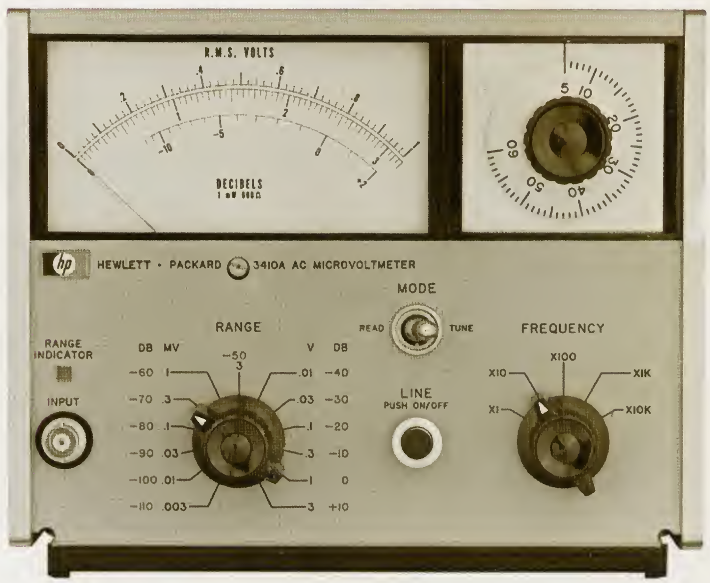
HP 3410A

OPERATING AND SERVICE MANUAL

AC MICROVOLTMETER

3410A



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HP 3410A

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CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

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OPERATING AND SERVICE MANUAL

(HP PART NO. 03410-90002)

MODEL 3410A
AC MICROVOLTMETER

SERIALS PREFIXED: 842-

Appendix C, Manual Backdating Changes (in the back of the manual), adapts this manual to instruments with Serials Prefixed: 648-, 719-, 728-, 731-, 735-, and 752-.

P. O. Box 301, Loveland, Colorado, 80537, U. S. A.

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Figure 1-1. Model 3410A AC Microvoltmeter

Table 1-1. Specifications

VOLTAGE RANGE: 3 μV full scale to 3 V full scale in 13 ranges.

FREQUENCY RANGE: 5 Hz to 600 kHz in 5 decade ranges.

VOLTAGE ACCURACY: % FULL SCALE

FREQUENCY

	5Hz–10Hz	10Hz–25Hz	25Hz–100Hz	100Hz–50kHz	50kHz–600kHz
30μV to 3V	±10%	±3%			±5%
10μV	±15%*	±10%*	±3%		±5%
3μV		±20%*	±10%	±3%	±10%

FREQUENCY DIAL ACCURACY: ±10% full scale (unlocked).

PHASE LOCK RANGE: Pull in, ±1% of full scale frequency.
Track, ±5% of full scale frequency.
Tracking speed, 0.5% of full scale/second

MAXIMUM NOISE REJECTION: 20 dB rms above full scale on all ranges for rated accuracy.

INPUT IMPEDANCE: 10 mV to 3 V range, 10 MΩ shunted by 10 pF.
3 μF to 3 mV range, 10 MΩ shunted by 20 pF.

METER: Responds to average value of input waveform; calibrated in rms value of sine wave. Linear voltage scales 0 to 1 and 0 to 3; dB scale -12 to +2 dB (0dB = 1 mW into 600Ω).

LOCAL OSCILLATOR OUTPUT: 4 V square wave into open circuit at the same frequency as the phase locked input signal.

RECORDER OUTPUT: +1 V into 1000Ω for full scale deflection. ±0.5 V adjustable offset level.

AC POWER: 115 or 230 V ±10%, 50 to 400 Hz, 22 W.

DIMENSIONS: Standard 1/2 module, 6-1/2" high, 7-3/4" wide, 11-1/2" deep, (164x196.9x292 mm).

*At lower frequencies and microvolt signal levels, meter fluctuations in the READ MODE may give the impression of an unstable lock condition. However, the 3410A will lock and track at these lower frequencies and provide a usable voltage indication.

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 3410A AC Microvoltmeter is a tuneable phase locking voltmeter designed to measure ac voltages from 3 microvolts to 3 volts full scale. When tuned to any discrete frequency between 5 Hz and 600 kHz, the 3410A will indicate the amplitude of the signal present at that frequency, rejecting all noise and non-harmonically related signals.

1-3. Two outputs are provided on the rear panel to extend the usefulness of the 3410A. The RECORDER OUT terminal provides a dc output that is proportional to meter deflection. This output, 1 V into 1 kΩ for full scale deflection, may be used to drive a pen recorder or other auxiliary equipment. A 5 V square wave at the tuned frequency, which may be used to drive an electronic counter for making precise frequency measurements, is available at the OSC OUT terminal.

1-4. The Model 3410A AC Microvoltmeter is shown in Figure 1-1, and Table 1-1 gives a list of its performance specifications.

1-5. OPTION.

1-6. Option 01 is a standard -hp- Model 3410A that has the dB scale placed uppermost on the meter face. This option is used to obtain greater resolution when making dB measurements.

1-7. INSTRUMENT AND MANUAL IDENTIFICATION.

1-8. Hewlett-Packard instruments are identified by a two-section eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 3410A described in this manual.

1-9. If a letter prefixes the serial number, the instrument was manufactured outside the United States.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for the installation and shipping of the Model 3410A Microvoltmeter. Included are initial inspection procedures, power and grounding requirements, installation information, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage received in transit. Also check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in the Performance Checks found in Paragraph 5- . If there is damage or deficiency, see the warranty on the inside front cover of this manual.

2-5. POWER REQUIREMENTS.

2-6. The Model 3410A can be operated from any source of 115 or 230 volts at 50 to 1000 Hz. The 115/230 V slide switch on the rear panel sets the instrument to operate from the desired line voltage. Power dissipation is less than 25 watts.

2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-9. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-10. INSTALLATION.

2-11. The Model 3410A is fully transistorized; therefore, no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F) or the relative humidity exceeds 95%.

2-12. <u>BENCH MOUNTING.</u>

2-13. The Model 3410A is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

2-14. <u>RACK MOUNTING.</u>

2-15. The Model 3410A may be rack mounted by using an adapter frame (-hp- Part No. 5060-0797). The adapter frame is a rack frame that accepts any combination of submodular units. It can be rack mounted only. For additional information, address inquiries to your -hp- Sales and Service Office. (See Appendix B for office locations.)

2-16. <u>COMBINATION MOUNTING.</u>

2-17. The Model 3410A may be mounted in combination with other submodular units by using a Combining Case (-hp- Model 1051A or 1052A). The Combining Case is a full module unit which accepts various combinations of submodular units. This full module unit can be bench or rack mounted and is analogous to any full module instrument.

2-18. REPACKAGING FOR SHIPMENT.

2-19. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-20 if the original container is to be used; 2-21 if it is not. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix for office locations.)

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach to the instrument a tag identifying the owner, indicating the service or repair to be accomplished, and giving the serial number of the instrument. In any correspondence, identify the instrument by model number and serial number.

2-20. If original container is to be used, proceed as follows:

a. Place instrument in original container. If original container is not available, a similar container can be purchased from your nearest -hp- Sales and Service Office.

b. Ensure that container is well sealed with strong tape or metal bands.

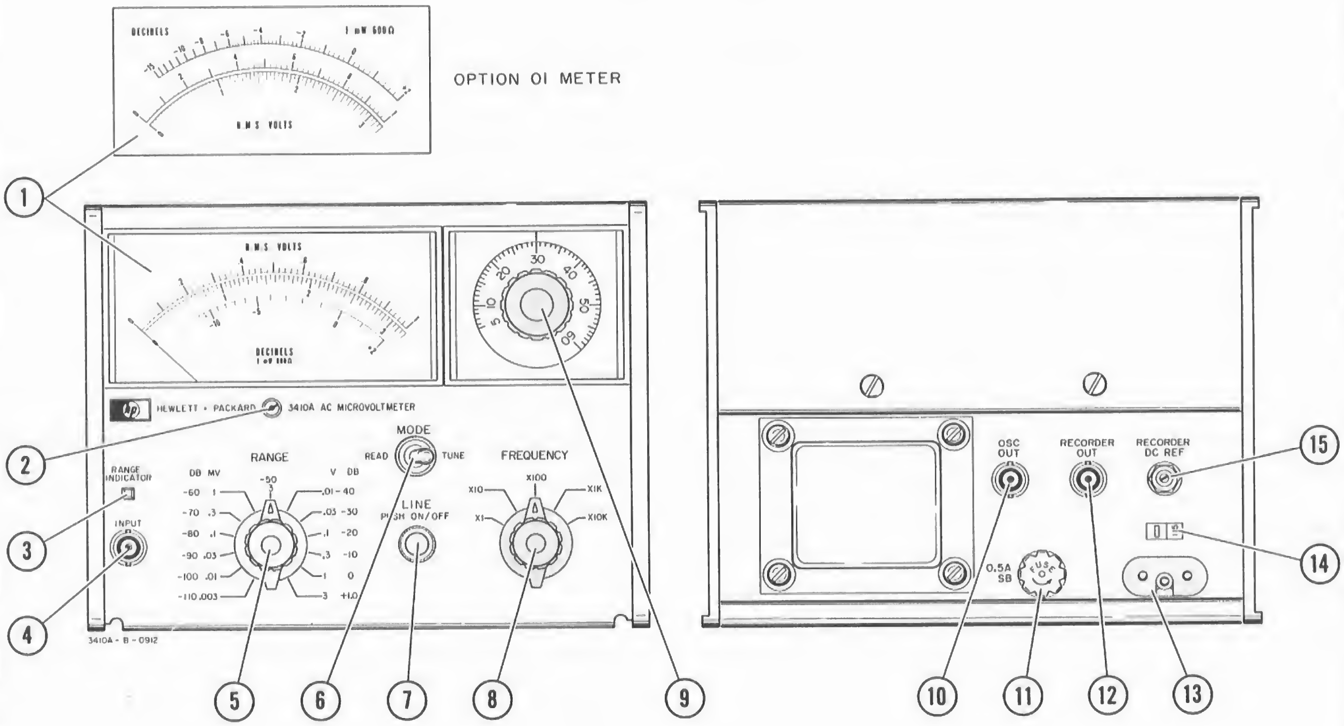
2-21. If original container is not to be used, proceed as follows:

a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of instrument and protect panel face with cardboard strips.

c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE" etc.



(1) Meter Scale: Indicates magnitude of tuned input signal in volts and dB. Option 01 has dB scale placed uppermost, for greater resolution in dB measurements.

(2) Mechanical Zero Adjustment: Provides a mechanical meter zero adjustment.

(3) RANGE INDICATOR: Indicates the voltage range of the total broadband signal input to the instrument.

(4) INPUT Terminal J1: Input connection for signal to be measured.

(5) RANGE Switch S1: Selects the full scale reading of the meter. DB setting on the RANGE switch adds algebraically to the dB reading of the meter.

(6) MODE Switch S3: Selects READ or TUNE mode of operation.

(7) LINE Switch S4: Applies primary power to the instrument. A lamp within the pushbutton glows when the instrument is on.

(8) FREQUENCY Switch S2: Selects one of five frequency ranges.

(9) FREQUENCY Dial R1: Tunes the 3410A within each frequency range. Dial reading multiplied by the FREQUENCY switch setting is the tuned frequency of instrument.

(10) OSC OUT Terminal J2: Provides a connection for the local oscillator output.

(11) FUSE F1: 1/2 amp fuse protects the instrument from current overloads.

(12) RECORDER OUT J3: Provides a connection for the dc output.

(13) Primary Power Connector J4: Connects primary power to instrument.

(14) 115/230 Volt Slide Switch S5: Sets 3410A to operate from either a 115 V or 230 Vac power source.

(15) RECORDER DC REF: Adjusts recorder output dc reference up to ±0. 5 V offset.

Figure 3-1. Location and Description of Controls and Indicators

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains instructions and information necessary for the operation of the 3410A AC Microvoltmeter. Included are identification of controls, indicators and connectors; turn on procedure; mechanical meter zero adjustment steps; and operating instructions.

3-3. CONTROLS, INDICATORS AND CONNECTORS.

3-4. Figure 3-1 identifies and describes the function of each operating control, indicator and connector of the Model 3410A.

3-5. OPERATION.

3-6. TURN ON PROCEDURES.

a. Set 115/230 volt slide switch, (14), to agree with the voltage of the primary power to be used.

b. Connect primary power to receptacle (13).

c. Depress LINE switch, (7). Lamp DS1, within switch pushbutton (7), will glow, indicating application of primary power.

3-7. MECHANICAL METER ZERO ADJUSTMENT.

3-8. The 3410A meter is properly zero-set when the meter pointer rests over the zero mark, with the instrument in normal operating position, at normal operating temperature, and turned off. Zero-set the meter as follows to obtain maximum accuracy and mechanical stability:

a. Turn instrument on and allow it to operate for 20 minutes, to ensure that meter movement reaches normal operating temperature.

b. Turn instrument off, and wait at least one minute for all capacitors to discharge.

c. Rotate the mechanical zero adjustment screw clockwise until the pointer is to the left of zero, and moving upscale toward zero. Stop when the pointer is exactly on zero; if the pointer overshoots, repeat this step.

d. When the pointer is exactly over zero, rotate the adjustment screw slightly counterclockwise to relieve tension on the pointer suspension. If the pointer moves left, repeat steps c and d, but make the counterclockwise adjustment smaller.

3-9. VOLTAGE MEASUREMENTS.

NOTE

Ground loops, due to unbalances between chassis grounds of instruments, may be present during usage of the 3410A on the more sensitive ranges. To prevent ground loops, isolate the 3410A from power line ground by attaching a three-prong to two-prong adapter to the power cord and leaving the adapter pigtail unconnected.

a. Turn on the 3410A and mechanically zero the meter, according to steps in Paragraph 3-7.

b. Set RANGE switch to 3 V, and set MODE switch to TUNE.

NOTE

Never place the mode switch to read position while tuning the instrument; because the instrument may respond to the wrong signal, thus giving a false reading.

c. Set the FREQUENCY range switch to the range of the signal to be measured.

CAUTION

DO NOT APPLY MORE THAN 100 V RMS TO INPUT. IF THIS LIMIT IS EXCEEDED, THE INSTRUMENT MAY BE DAMAGED.

d. Connect the signal to be measured to the 3410A, and downrange the RANGE switch until the RANGE INDICATOR lights.

e. Slowly tune the FREQUENCY dial through the frequency of interest, until a meter reading is obtained. If the meter pegs, uprange the RANGE switch to obtain an on-scale reading.

NOTE

If the instrument is upranged to obtain an on-scale reading, the RANGE INDICATOR lamp may go out. This is a normal indication which will happen whenever the signal being measured is larger than the summation of noise and other signals present.

If the instrument is downranged from the range on which the RANGE INDICATOR lights, it may not operate with rated accuracy.

f. After on-scale reading is obtained, place the MODE switch to READ position. The meter will indicate the RMS voltage amplitude of the sinusoidal input signal. The meter indication in READ position may be same as in TUNE position. If so, this indicates that input signal contains relatively little low frequency noise.

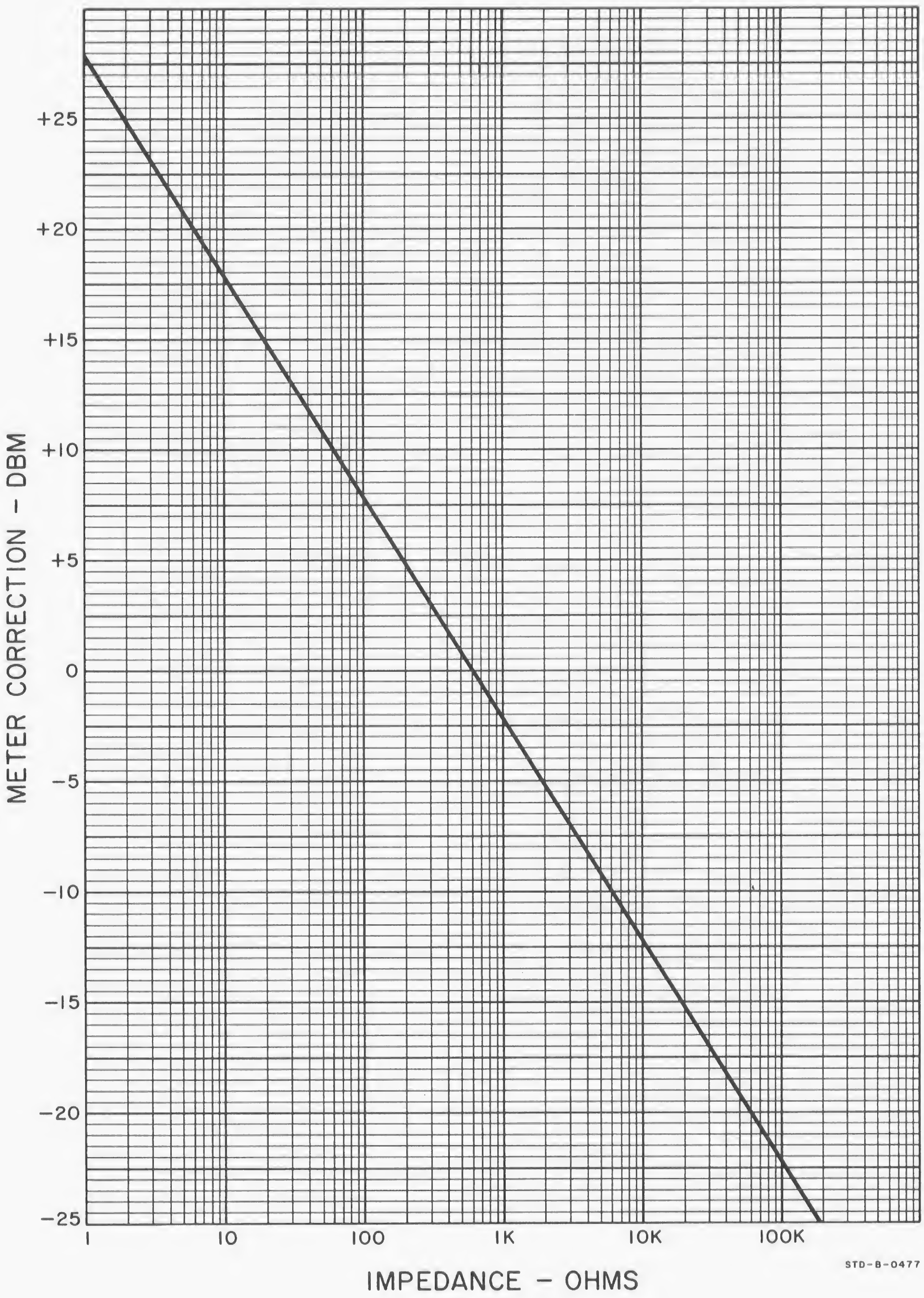


Figure 3-2. Impedance Correction Graph

3-10. DB MEASUREMENTS.

a. A dB measurement is equal to the algebraic sum of the meter indication and the RANGE setting. For example: if the RANGE setting is +10 dB and the meter indication is -3 dB, the actual dB measurement is +7 dB.

b. The dB scale of the 3410A is calibrated to read in dBm when a 600Ω load is used. 0 dBm is equivalent to 1 milliwatt dissipated by a 600Ω load. Therefore, all dBm measurements must be made across a total impedance of 600Ω. Measurements across all other impedances will be in dB, but not dBm.

c. A reading in dB may be converted to dBm by using the Impedance Correction Graph (Figure 3-2). For example: to convert a -30 dB reading across 200 ohms to dBm, locate the 200Ω impedance on the bottom of the graph. Follow the impedance line to the heavy black line, and read the meter correction at that point. The correction for 200 ohms is +5 dBm; thus the corrected reading is -25 dBm.

3-11. LOW LEVEL, LOW FREQUENCY MEASUREMENT TECHNIQUE.

3-12. Due to the difficulty of filtering very low level, low frequency signals and noise, a special technique is required when locking the 3410A to signals between 10 Hz and 100 Hz on the 3 μV range and between 5 Hz and 25 Hz on the 10 μV range. Use the following procedure when making measurements in this voltage and frequency range:

a. Turn the 3410A on and mechanically zero meter, according to the steps in paragraph 3-6.

b. Set the RANGE switch to the voltage range of the signal (3 μV or 10 μV).

c. Set the FREQUENCY range switch to the range of the signal.

d. Set the MODE switch to TUNE, and slowly tune the FREQUENCY dial until a meter swing greater than 1/10 of full scale is obtained. This indicates that the 3410A is tuned within the capture range of the input signal.

e. Place the MODE switch to READ, and allow 30 seconds for the 3410A to lock to the signal, and indicate the amplitude of it.

f. If the 3410A does not lock to the signal within 30 seconds, leave the MODE switch in READ position and tune the instrument first slightly above and then slightly below the previous frequency setting. After each change in frequency, allow 30 seconds for the instrument to lock to the signal.

3-13. OPTION 01 INSTRUMENT.

3-14. Operating procedures for the 3410A with Option 01 are the same as the operating procedures for the standard instrument. The only difference between the two models is the scale layout. The 3410A with Option 01 has a dB scale that reads from -15 to +2, instead of from -12 to +2. Also, the dB scale is the upper scale on the meter face for better resolution.

3-15. USE OF OUTPUTS.

CAUTION

DO NOT CONNECT MORE THAN 5 V RMS TO THE OUTPUT TERMINALS. IF THIS LIMIT IS EXCEEDED, THE INSTRUMENT MAY BE DAMAGED.

3-16. OSC. OUT.

3-17. Connect OSC. OUT to the sync input of an oscilloscope, to the input of a counter to make precise frequency measurement, or to any other instrument where a square wave which is phase locked to the input signal is useful.

3-18. RECORDER OUT.

a. Connect the RECORDER OUT terminal to the input of a recorder, using a 1000Ω load resistor to obtain rated output of 1 mV for full scale meter deflection.

b. Adjust the RECORDER DC REF pot to offset the output up to ± 0.5 Vdc.

3-19. EFFECT OF INTERFERING SIGNALS AND HARMONICS.

3-20. INTERFERING SIGNALS.

3-21. The graph of Figure 3-3 shows how the accuracy of the 3410A is affected by the relationship of the amplitude to percent of frequency sep ration between an interfering signal and the desired signal. The shaded portion of the graph indicates the conditions under which the accuracy of the 3410A would be less than specified. For example: Assume that the 3410A is locked to a signal at 10 kHz, and that an interfering signal at 16 kHz is present. The interfering signal is separated from the tuned signal by +6 kHz, thus the frequency separation in percent of full scale frequency of the range is +10%. As shown on the graph, the amplitude of this signal could be as much as 10 dB above the amplitude of the tuned signal without degrading the specified accuracy of measurement.

3-22. HARMONICS.

3-23. Even harmonics or submultiples of the tuned frequency do not seriously affect the accuracy of the 3410A. However, relatively large signals at or near a harmonic or a submultiple frequency can substantially

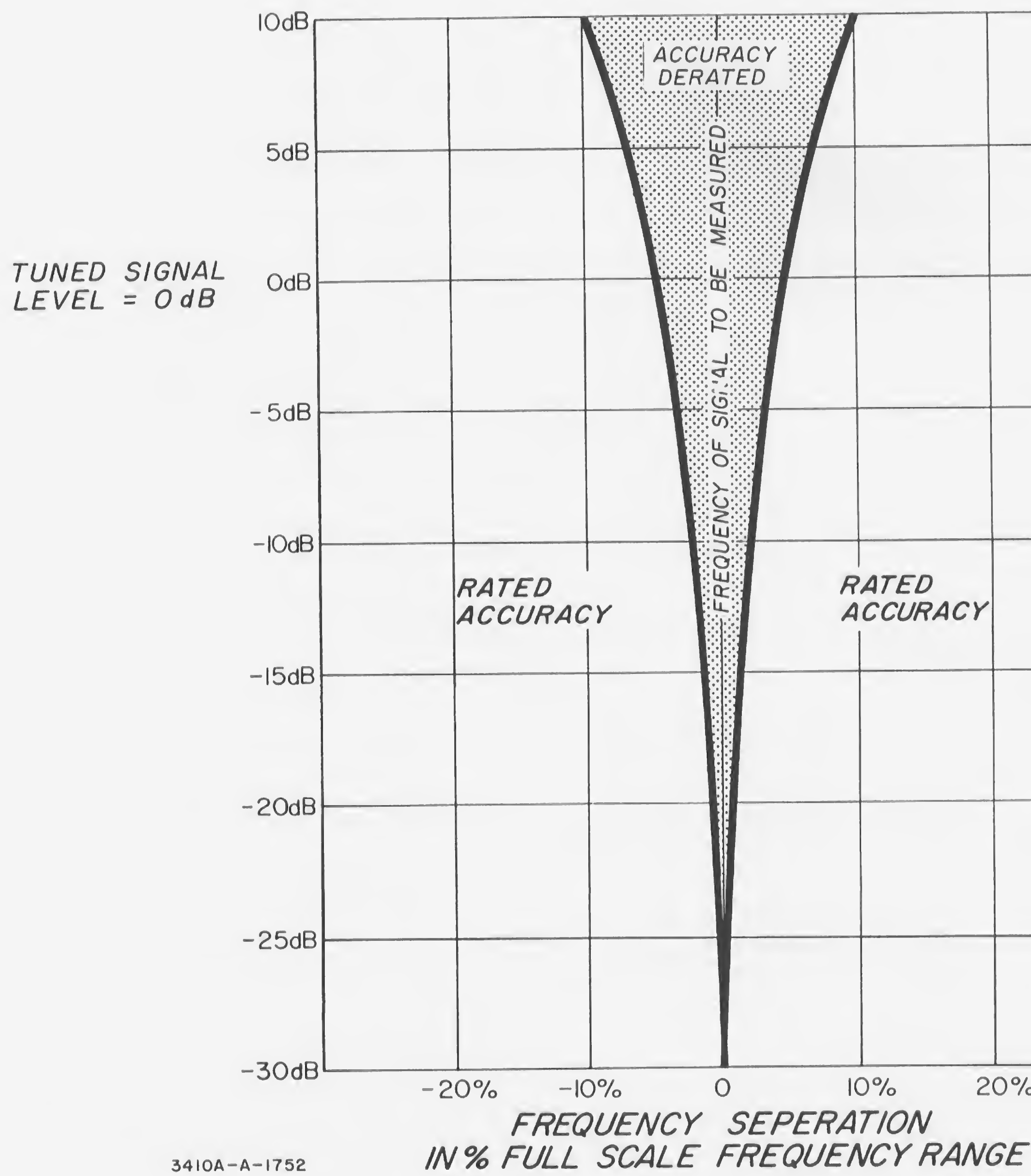


Figure 3-3. Effect of Close Interfering Signals

effect the reading. Figure 3-4 shows the greatest effect that interfering harmonics and submultiples should ever have. In many cases, interfering signals of larger amplitudes can be tolerated without derating the accuracy of the 3410A. This is dependent upon where in the decade range the tuned frequency falls, and also upon the phase relationship between the tuned signal and the interfering signal.

3-24. Figure 3-5 shows the effect of third harmonic signals of various phases. Interfering signals in phase and those 180° out of phase with the tuned signal cause the greatest error in reading. An interfering signal 90° out of phase would have no effect on the meter indication. A signal having 30% third harmonic distortion would have a 1.1 ratio, or read 110% of the actual rms value of the tuned signal. The dashed line on Figure 3-5 shows the effect that third harmonic distortion, regardless of phase, has upon average-responding instruments. This completes Section III except for Figure 3-5.

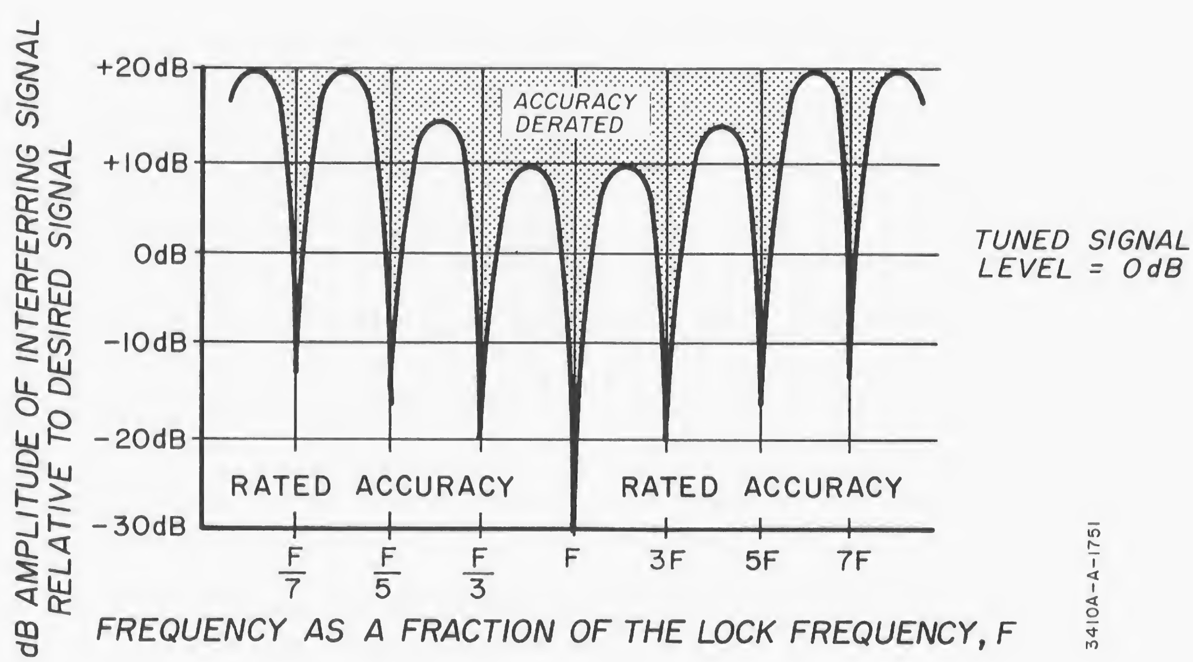


Figure 3-4. Effect of Odd Harmonics and Submultiples

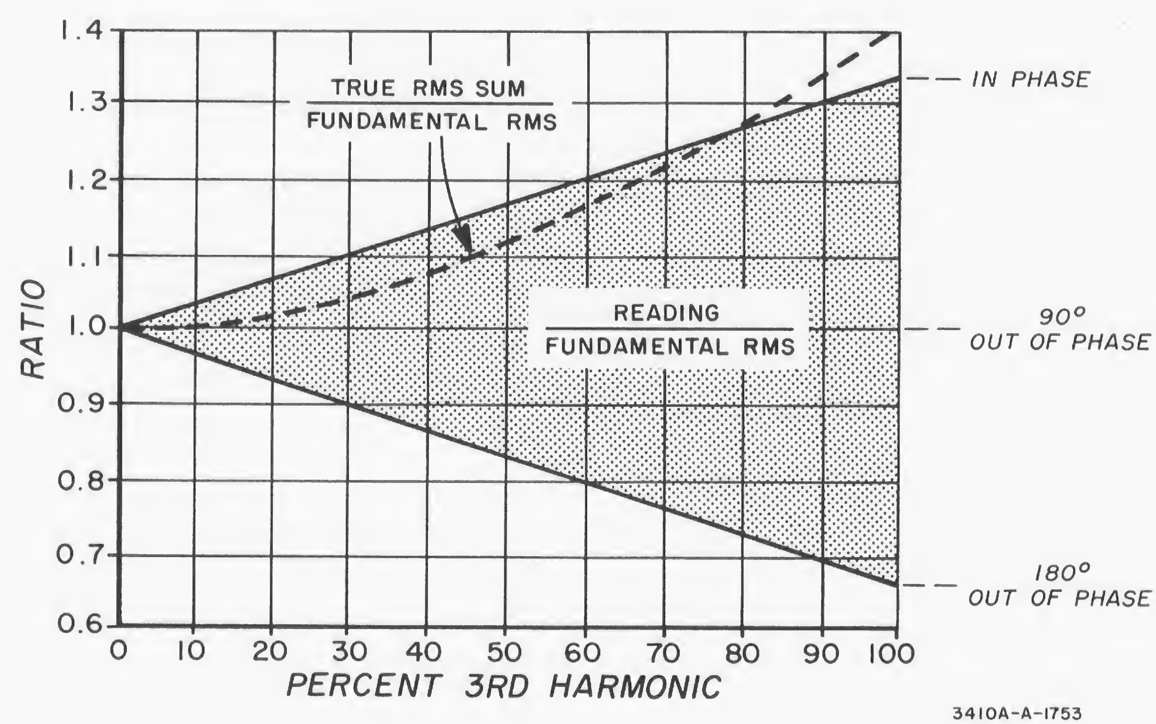


Figure 3-5. Effect of Third Harmonic

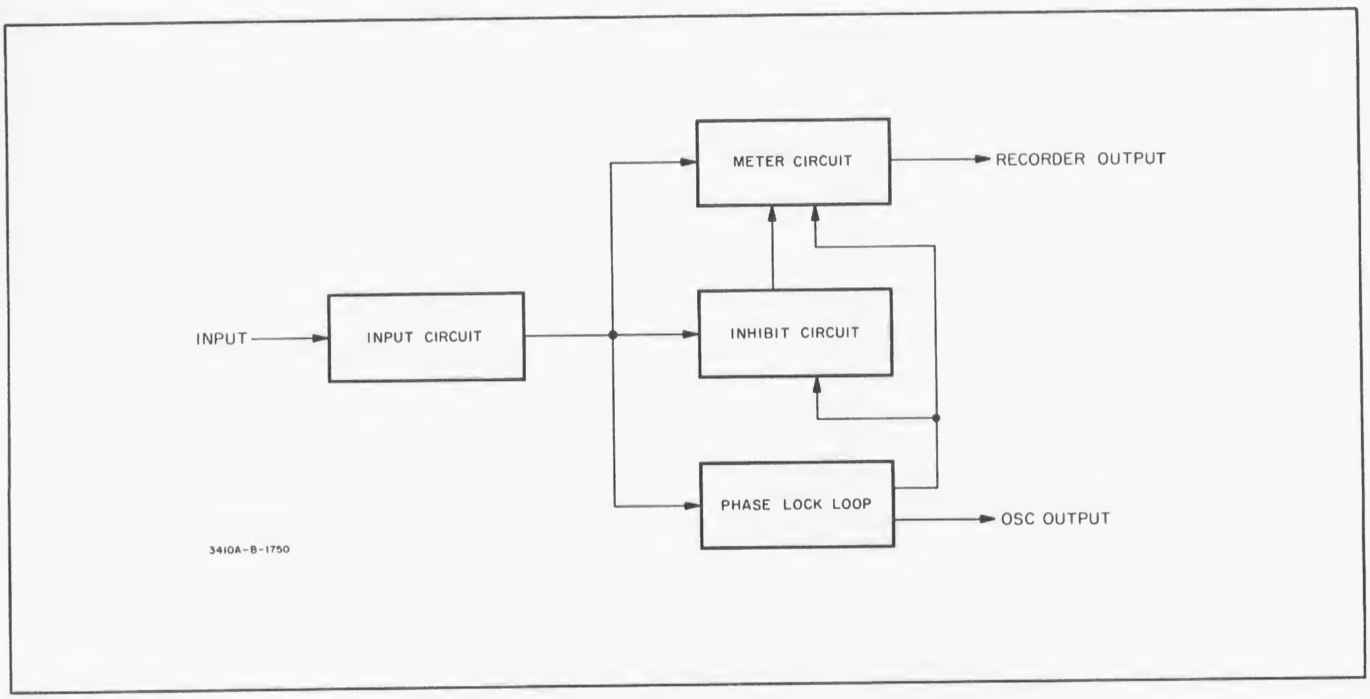


Figure 4-1. Simplified Block Diagram

SECTION IV
THEORY OF OPERATION

4-1. GENERAL DESCRIPTION.

4-2. The Model 3410A is a tuneable phase locking ac voltmeter that measures voltages from 3 microvolts to 3 volts full scale. When tuned to any discrete frequency between 5 Hz and 600 kHz, the 3410A will indicate the amplitude of the signal present at the tuned frequency (F_T); noise and all non-harmonically related signals will be filtered out. The instrument has two outputs: A four volt square wave at the voltmeter's tuned frequency, and a dc recorder output that is proportional to the meter deflection (1 mA into 1000 ohms for full scale deflection).

4-3. SIMPLIFIED BLOCK DIAGRAM DESCRIPTION.

4-4. Refer to Figure 4-1 for a simplified block diagram of the 3410A.

4-5. The input signal is applied to the Input Circuit; which furnishe the proper amount of attenuation and amplification, depending upon the setting of the range selector switch.

4-6. From the Input Circuit, the signal is coupled to the Meter Circuit, the Inhibit Circuit, and the Phase Lock Loop.

4-7. The Phase Lock Loop contains a local oscillator, which is tuned to the frequency of the input signal. The local oscillator is phase locked in phase with the input signal and furnishes the four volt square wave output at the rear panel of the instrument. Outputs from the local oscillator are also supplied to the Inhibit Circuit and the Meter Circuit.

4-8. The Inhibit Circuit is necessary to prevent a false meter indication when the 3410A is tuned to submultiples of the input signal. The local oscillator will lock to any odd submultiple of the input frequency. When the 3410A is in the TUNE mode, the Inhibit Circuit will short out the meter when the instrument is tuned to any odd submultiple of the input signal, preventing any erroneous reading from being present. When the instrument is tuned to the frequency of the input signal, the Inhibit Circuit will allow the meter to indicate a reading.

4-9. The Meter Circuit, using a square wave from local oscillator, detects the input signal and furnishes a dc level to the meter. The Meter Circuit also provides a dc output from the instrument which may be used as a recorder input.

4-10. FUNCTIONAL BLOCK DIAGRAM DESCRIPTION.

4-11. The following description refers to Figure 7-1 on Page 7-3/7-4.

4-12. INPUT CIRCUIT.

4-13. The signal to be measured is applied to the pre-attenuator, where it is either attenuated by 60 dB or coupled directly to the preamplifier, depending on the RANGE switch setting. The preamplifier provides the signal with 20 dB of gain, and applies it to the post attenuator, which attenuates the signal in progressive steps of 10 dB each, as a function of the RANGE switch. The signal is given an additional 80 dB of gain by the post amplifier, after which it is applied to the range indicator circuit and to the high pass filter. The range indicator circuit is set to light lamp DS2 whenever the post amplifier output amplitude goes 10 dB or more above the amplitude required for a full scale meter indication. Its purpose is to aid in determining the voltage range of the signal to which the instrument is being tuned. The high pass filter with a single pole roll-off, attenuates signals of frequencies below F_T, and applies the filtered output to the phase lock loop, the inhibit circuit, and the meter circuit.

4-14. PHASE LOCK LOOP.

4-15. The phase lock loop locks to the signal at F_T, and provides a square wave to drive the modulators in the inhibit and meter circuits at the proper frequency and phase. The voltage controlled oscillator (VCO) generates a square wave at a frequency which is four times the tuned frequency. The VCO provides a clock input for the two integrated circuit flip-flops, IC1 and IC2, which are interconnected to divide the frequency by four, thus providing two square wave outputs at the tuned frequency which are 90^o out of phase. (The VCO, in conjunction with the two flip-flops, is herein referred to as the "local oscillator.") One square wave drives the phase lock modulator, and the other drives the meter and inhibit modulators. When the square wave to the phase lock modulator is 90^o out of phase with the input signal, the modulator dc output will be zero, and the 3410A will be phase locked to the input signal. If the phase of the input shifts, the modulator will supply a dc voltage to the phase lock amplifier. The polarity and amplitude of this dc voltage will be determined by the direction and amount, respectively, of the shift in phase. This dc voltage will be amplified by the phase lock amplifier and applied to the VCO, causing it to shift the phase of the local oscillator output in the direction necessary to maintain phase lock. Once the circuit is locked to a signal, it will remain locked unless the input frequency deviates more than ±5% or varies at a rate exceeding 1/2% of full scale frequency per second.

4-16. PHASE LOCK LOOP.

4-17. The phase lock loop will lock to any signal which will translate to dc when beat with the local

oscillator output. If the instrument is tuned to an odd submultiple of the input signal, the phase lock loop will lock to it, and the meter circuit will produce a reading which is not meaningful. Therefore, all such signals must be inhibited before reaching the meter. The inhibit modulator is preceded by a tuned low pass filter. The low pass filter has a cutoff frequency equal to F_T. When the input signal is at F_T, the relative gain of the meter and inhibit circuits is such that the inhibit amplifier produces the larger voltage, causing the comparator to allow the meter to read.

4-18. When the instrument is tuned to any odd submultiple of the input signal, the output amplitude of the inhibit amplifier is less positive than that of the meter amplifier; and the comparator will not allow the meter to indicate a reading if the instrument is in TUNE mode. If it is in READ mode, a false indication will read on the meter. Figure 4-2 shows the circuit conditions present when the instrument is tuned to the input frequency and when it is tuned to the fifth submultiple of the input frequency.

4-19. METER CIRCUIT.

4-20. The filtered input signal is applied to the meter modulator, which is driven at F_T by a square wave from the local oscillator. The square wave causes the meter modulator to produce half-wave rectification of the signal. The dc output of the modulator is amplified by the meter amplifier and applied to both the meter and the comparator. If the MODE switch is in the TUNE position, the comparator will let the meter indicate the amplitude of only the tuned signal. For all other signals, the comparator will close a relay and place a short across the meter. If the MODE switch is in the READ position, the inhibit circuit is deactivated; also, the meter response time is increased by a factor of 1,000.

4-21. DETAILED CIRCUIT DESCRIPTION.

4-22. Refer to Figures 7-2 through 7-6 for the following discussion.

4-23. INPUT CIRCUITRY.

4-24. The preattenuator is comprised of an RC voltage divider and two reed relays. Reed relay A1K1 is energized by -25 V from the RANGE switch on the 3 μV through 3 mV ranges, routing the input signal directly to the preamplifier with no attenuation. On the higher ranges, A1K2 is energized, directing the signal through the voltage divider, thus attenuating it by 60 dB.

4-25. The preamplifier provides the signal with 20 dB of gain and matches the high impedance of the preattenuator to the much lower impedance of the post attenuator. A field effect transistor, A1Q1 is used as the input stage of the amplifier because of its low noise characteristics and high input impedance. The signal is taken from the drain of A1Q1 and is further amplified by A1Q2 and A1Q3. Feedback from the emitter of A1Q2 bootstraps the value of A1R14, the drain load of A1Q1. Feedback from the source of A1Q1 bootstraps the input impedance of the preamplifier and keeps it at a high level over all ranges of inputs. Gain stability and linearity of the circuit are maintained by feedback from the emitter of A1Q3. A1R10 provides a bias adjustment for the field effect transistor, A1Q1.

4-26. The post attenuator is a precision resistive voltage divider that operates as a function of the RANGE switch. On the lowest voltage range, the signal from the preamplifier is applied through resistor S1R1 to the post amplifier, and is not attenuated. The resistive divider network attenuates the signal in six progressive steps of 10 dB each, for the twelve higher ranges. Each of the six steps is used twice (in conjunction with the preattenuator) to obtain a total signal attenuation range of 0 to 120 dB.

4-27. Figure 7-2 shows the post amplifier which is made up of two separate sections, providing a total of 40 dB of gain. The section including A2Q1 through A2Q4 has a gain of 40 dB. The gain of this section is

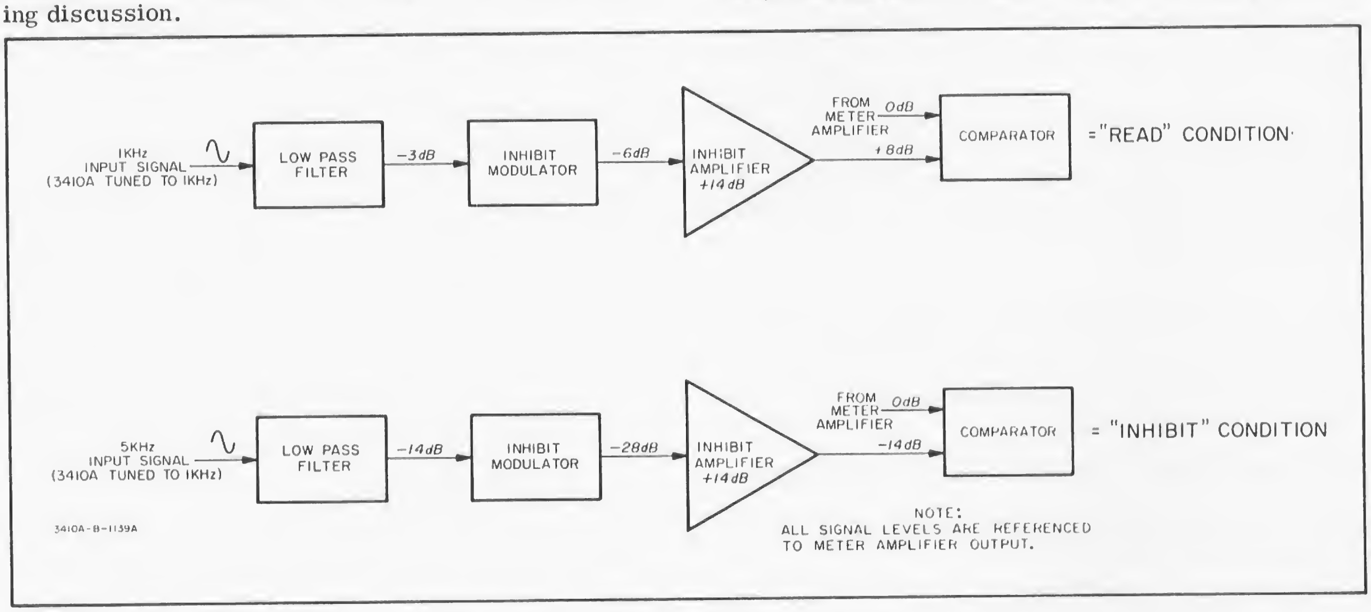


Figure 4-2. Inhibit Circuit Operation

controlled by feedback applied through A2R6 to the base of A2Q2. The second section, including A2Q5 through A2Q10, has a gain of 40 dB, controlled by feedback through A2R22 to the base of A2Q5.

4-28. It should be noted that the +45 V is decoupled from the +45 V, and that the -25 V is decoupled from the -25 V. The decoupling takes place in LC filters shown at the left of Figure 7-3. When the A2 board is in the instrument, all grounds on the board are common. However, if the board is out of the instrument, there are two separate ground circuits. These ground circuits are shown on Figure 7-3 as $\bigtriangledown_2$ and $\bigtriangledown_{12}$, being numbered like the pin number to which each circuit is connected.

4-29. The amplitude of the signal at the output of the post amplifier is approximately 400 mV RMS, for a full scale meter indication. The signal at this point is the composite signal which contains the desired signal as well as any noise or signals of other frequencies that may be present. This signal includes the noise generated in the 3410A input amplifiers, and may vary from 360 mV to 420 mV. If the composite signal amplitude becomes greater than approximately 1.2 V RMS (10 dB above full scale), the range indicator circuit will light lamp DS2.

4-30. When the post amplifier output exceeds 1.2 V peak, suppressor diodes A2CR3 through A2CR6 will conduct, and apply the signal to A2Q11, where it will be amplified. The ac signal will then be converted to a positive dc by A2CR7 and filtered by A2C14. This dc signal is applied through emitter follower A2Q12 to a Schmitt trigger circuit, causing A2Q13 to conduct and draw current through lamp DS2. The Schmitt trigger will remain in this state, lighting the RANGE INDICATOR lamp, until the voltage level at the post amplifier output drops below 1.2 V RMS and causes it to switch back to its original state.

4-31. The high pass filter has a single-pole roll off (6 dB per octave) which is initiated at the tuned frequency, thus attenuating signals of frequencies below F_T. Selection of a certain frequency range is made by switching to one of five capacitors (S2C1 through S2C5), selected by the FREQUENCY range switch. The FREQUENCY dial (R2A) is then tuned to the frequency of interest, establishing the roll off point of the filter.

4-32. PHASE LOCK LOOP.

4-33. The heart of the phase lock loop is the voltage controlled oscillator, which generates a square wave at four times the tuned frequency. The VCO frequency may be linearly tuned over a decade range by changing the position of the FREQUENCY dial (R1), consequently changing the bias voltage on A3Q17. Range switching of the four lower frequency ranges is accomplished by switching capacitors S2C22 through S2C25 and S2C26 through S2C29, which are ganged to the FREQUENCY range switch. On the highest frequency range, capacitors A3C12 and A3C16 provide phase adjusted feedback to sustain oscillations. Resistors A3R44 and A3R45 adjust the VCO frequency to track the FREQUENCY dial indication. A3C14 adjusts the oscillator frequency on the highest range, to compensate for stray capacitance. A3Q13 and A3Q14 act as current sources for charging S2C22 through S2C29. If the VCO does not start oscillating immediately upon turn-on, A3Q11 turns off, turning on A3Q10. This causes A3Q13 and A3Q14 to be turned off momentarily. The VCO is thus recycled and oscillations should begin. Normally, A3Q11 is conducting.

4-34. The purpose for the VCO frequency being four times the tuned frequency is to obtain a 90° phase shift through flip flops IC1 and IC2. As shown in Figure 4-3, the leading edge of every negative pulse from the VCO changes the state of first one and then the other flip flop. As the time between each positive pulse is always the same, a perfect 90° phase shift between the local oscillator outputs is assured.

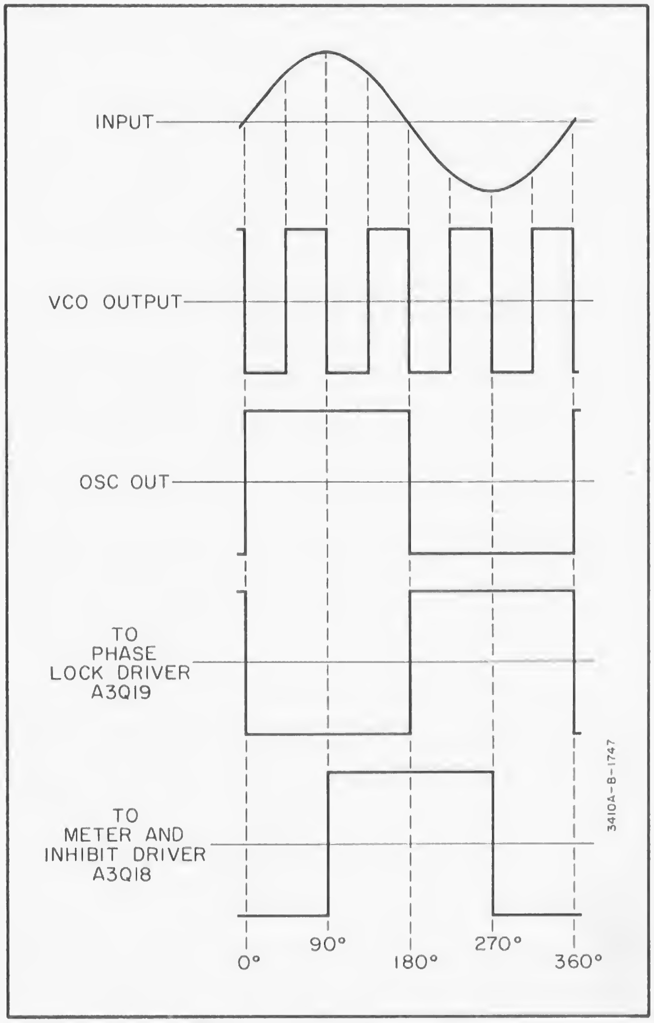


Figure 4-3. Local Oscillator Waveforms

4-35. One of the local oscillator outputs, a square wave at the tuned frequency, is applied through driver transistor A3Q19 to the base of the phase lock modulator, A3Q3. Refer to Figure 4-4 for modulator waveforms. The positive half of the square wave gates A3Q1 on, and shorts to ground the portion of the input signal present at that time. Therefore, only during the negative portion of the square wave will the input signal be passed to the phase lock amplifier.

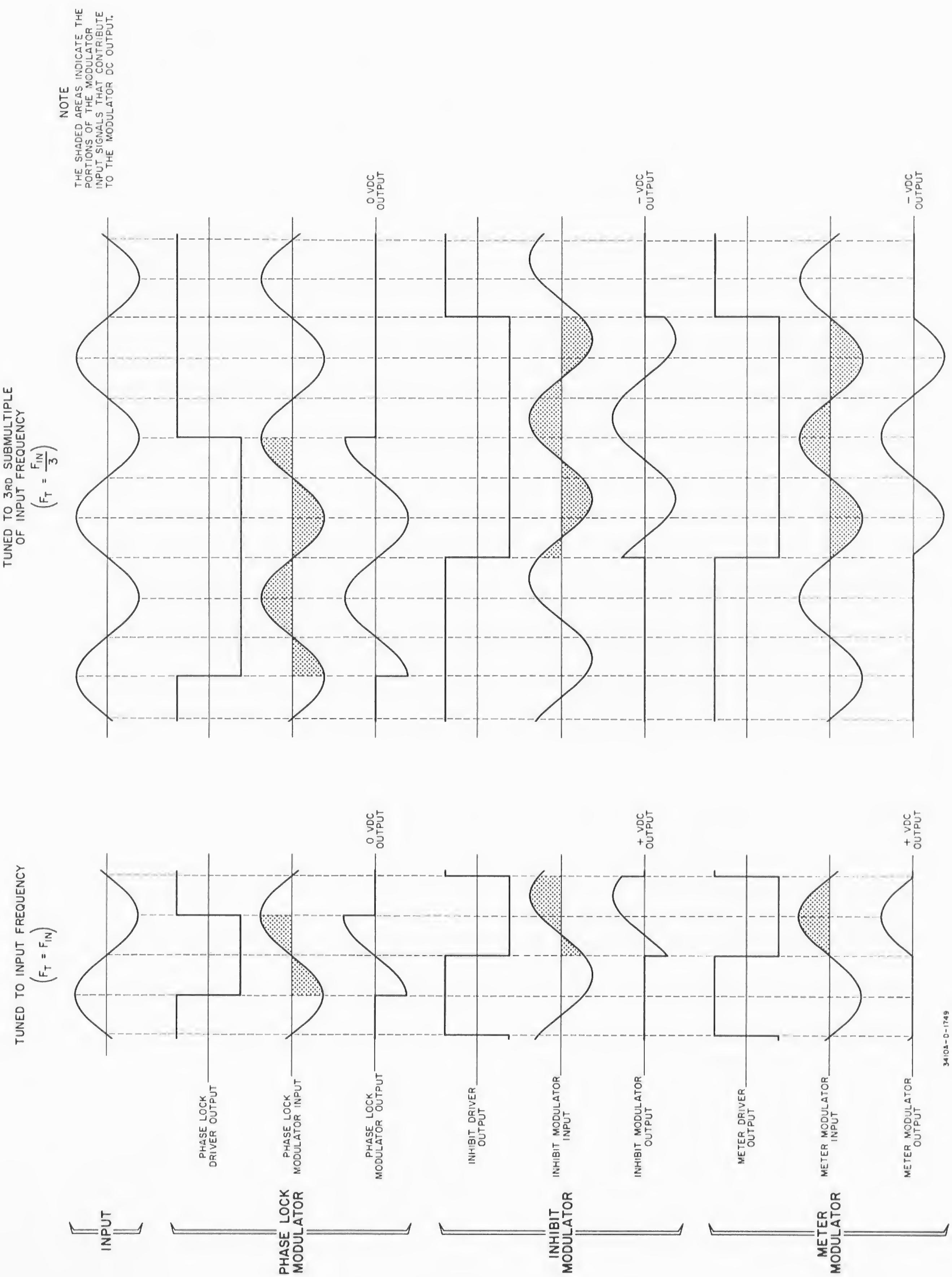


Figure 4-4. Modulator Waveforms

4-36. The phase lock amplifier is a low pass differential amplifier that uses feedback to achieve a low pass filtering action. The feedback is taken from the emitter of A3Q6 and is amplified by A3Q7 and A3Q8 before being applied to the filter capacitors. This feedback network determines the gain with respect to frequency, of the phase lock amplifier, therefore determining the overall gain of the phase lock loop. The output of the phase lock amplifier is applied through emitter follower A3Q9 to the bases of A3Q13 and A3A14, causing the oscillator to shift phase until the input to the phase lock amplifier returns to the quiescent state. Thus the VCO remains locked to the input signal. Resistor A3R15 adjusts the bias on A3Q4A and A3Q4B.

4-37. INHIBIT CIRCUIT.

4-38. The inhibit signal is taken from the output of the buffer amplifier A3Q1 and A3Q2, and passed through the low pass filter. The low pass filter passes the signal to which the instrument is tuned, shifts it 45° in phase, and attenuates it by 3 dB. The filtered signal is then applied through a buffer amplifier, A3 Q21 and A3Q22, to the inhibit modulator, A3Q23. Driver transistor A3Q18 applies a square wave from the local oscillator to A3Q23, gating it on during the positive half cycle, and off during the negative half cycle. When A3Q23 is gated on, the signal is shorted to ground. Hence, the signal is passed to the inhibit amplifier only during the negative portion of the square wave. The signal and the square wave are 135° out of phase; consequently the signal passed by the modulator is a net positive dc, as shown in Figure 4-4. The amplitude of this dc signal will be approximately 3 dB less than the average value of the signal had it been perfectly half-wave rectified (as in the meter circuit). Thus the inhibit modulator output is a total of 6 dB less than the meter modulator output. This signal is then applied to the inhibit amplifier, which has 14 dB more gain than the meter amplifier. Therefore, the dc signal applied through emitter follower A4Q10 to the comparator is 8 dB greater than the meter circuit signal to the comparator. Under these conditions, the Schmitt trigger, A4Q11 and A4Q12, will switch states and open relay A4K1, allowing the meter to read.

4-39. If the instrument is locked to a submultiple of the input signal, the inhibit circuit input to the comparator will be considerably less than the input from the meter circuit and will not allow a "read" condition. This occurs because the inhibit signal will be attenuated more than 6 dB by the frequency discriminator and inhibit modulator. For example, if the input signal is at 5 kHz, and the 3410A is tuned to 1 kHz, the discriminator will attenuate the 5 kHz signal 14 dB and shift it 78° in phase. (Refer to Figure 4-2 for a diagram of the inhibit circuit operation). This phase shift will cause an efficiency loss of 14 dB in the modulator, effecting a total loss of 28 dB, as compared with the meter circuit output. The inhibit amplifier will make up only 14 dB of the difference; hence the comparator will not open the reed relay, and the meter will remain inhibited. Resistor A4R26 adjusts the bias on A4Q9A and A4Q9B, to balance the inhibit amplifier.

4-40. METER CIRCUIT.

4-41. The high pass filter output is applied through buffer amplifier A3Q24 and A3Q25 to the meter modulator, A3Q26. A3Q18 drives the modulator at the tuned frequency with a square wave from the local oscillator. The square wave is 180° out of phase. with the tuned signal, affording perfect half wave rectification, as shown in Figure 4-4. The rectified signal is applied to the meter amplifier, a low pass differential amplifier that has a response time of 0.1 seconds when the MODE switch is in the TUNE position. When the MODE switch is in the READ position, the circuit response time is increased to 100 seconds, through use of feedback amplification to bootstrap the value of filter capacitors A4C19 and A4C20. The amplifier output is applied through diode A4CR26 to the comparator and through resistors A4R60 and A4R61 to the meter.

4-42. Resistor A3R55 is adjusted at 600 kHz to calibrate the meter by smoothing the outputs of the inhibit and meter modulators. The meter is calibrated at 400 Hz by A4R61, which adjusts the current to the meter. Resistor A4R52 adjusts the bias on A4Q19A and A4Q19B to balance the meter amplifier.

4-43. OUTPUTS.

4-44. The signal from the connection between pin 3 of flip-flop IC2 and pin 5 of flip-flop IC1 is applied to the oscillator output terminal, J2. This signal is a four volt square wave at the tuned frequency, in phase with the input.

4-45. The meter amplifier output is amplified by A4Q20, and applied to the recorder output terminal, J3. This output may be offset ± 0.5 V, by adjusting resistor R3, which controls the bias on the base of A4Q21.

4-46. POWER SUPPLY.

4-47. The power supply provides regulated outputs of +45V, +30V, and -25V. The positive supply utilizes a Darlington configuration series regulator, A4Q1 and Q1, to maintain output stability. The +45V is applied to transistor A4Q3, which regulates the +35V output. A4CR12 is selected to make the +30V output between +2.8V and 29.8V. Resistor A4R6 adjusts the +45V output, and as a result adjusts the +30V output. The -25V supply operates similarly to the +45V supply, and may be adjusted by A4R19.

Table 5-1. Required Test Equipment

Instrument Type	Specifications	Recommended Model
Electronic Counter	Frequency Range: 5 Hz to 600 kHz Accuracy: ±2 counts	-hp- Model 5532A Electronic Counter
AC Voltmeter Calibrator	Voltage Range: 3 mV to 3 V Accuracy: ± 0.2% at 400 Hz	-hp- Model 738BR Voltmeter Calibrator
Test Oscillator	Voltage Range: 3 mV to 3 V Frequency Range: 10 Hz to 600 kHz Flatness: ±0.25%	-hp- Model 652A Test Oscillator
Attenuator	Attenuation Range: 0dB to 60 dB Frequency Range: 10 Hz to 600 kHz	-hp- Model 355D Attenuator Set
Function Generator	Voltage Range (sine wave): 1 V Frequency Range: 45 kHz to 55 kHz Sweep Frequency (triangle wave): 0.025 Hz	-hp- Model 3300A Function Generator with 3301A plug in and -hp-Model 3300A Function Generator with 3304A plug in
AC/DC Voltmeter	Frequency Range: 10 Hz to 600 kHz Voltage Range: DC - 100 mV to 100 V AC - 10 mV to 100 V Accuracy (AC and DC): ±2% full scale	-hp- Model 427A Voltmeter
Oscilloscope	Bandwidth: 5 Hz to 600 kHz Sensitivity: 5 mV/cm	-hp- Model 140A Oscilloscope with 1405A plug in
Terminating Resistance	Feedthrough: 50 Ω ± 1%	-hp- Model 11048B Feedthrough Termination
Resistor	Fxd: 200 KΩ ± 1%	-hp- Part No. 0757-0782
Extender Board	15 pin	-hp- Part No. 5060-0049

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains maintenance and service information for the -hp- Model 3410A AC Microvoltmeter. Included are Performance Checks, Adjustment and Calibration Procedures, and Troubleshooting information.

5-3. REQUIRED TEST EQUIPMENT.

5-4. The equipment needed to perform the checks and adjustments in this section is listed in Table 5-1. If the recommended model is not available, any instrument having specifications equal to or better than those listed in Table 5-1 may be used.

5-5. PERFORMANCE CHECKS.

5-6. The Performance Checks are provided as a guide for checking the Model 3410A against published specifications. These checks may be used for incoming inspection, periodic maintenance, and specification checks after repair. A Performance Check Test Card is provided at the end of this section for recording the results of the Performance Checks. If the instrument fails to meet any of its specifications, perform the Adjustment and Calibration Procedures.

NOTE

Before beginning the Performance Checks, mechanically zero the meter according to the steps in Paragraph 3-7.

5-7. VOLTAGE ACCURACY.

5-8. This check requires the following test equipment. Voltmeter Calibrator (-hp- Model 738BR), Attenuator (-hp- Model 355D), and a Test Oscillator (-hp- Model 652A).

5-9. Connect the voltmeter calibrator to the 3410A, as shown in Figure 5-1. The test oscillator and attenuator shown in the figure will be used later in the check.

5-10. 3 V RANGE.

a. Set the 3410A controls as follows:

MODE . . . . TUNE
RANGE . . . . 3 V
FREQUENCY X10
FREQUENCY Dial 40

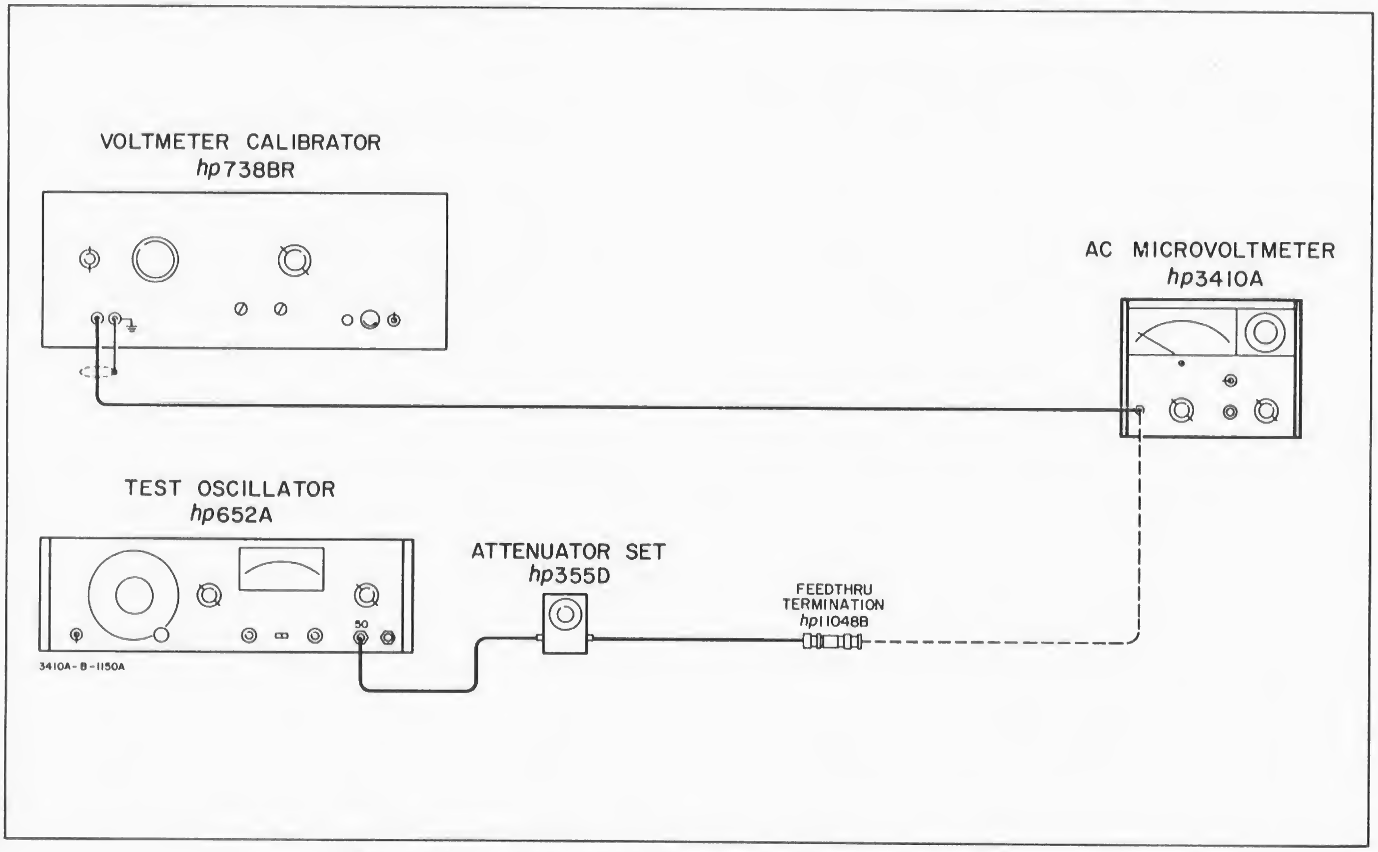


Figure 5-1. Accuracy and Frequency Response Check

b. Set the voltmeter calibrator for a 3 V rms output at 400 Hz.

c. If necessary, tune the 3410A FREQUENCY dial until the instrument locks to the signal; then place the MODE switch to READ position.

d. Note the 3410A meter indication; if not within tolerances listed in Table 5-2, perform meter calibration, Paragraph 5-40. Record this indication.

e. Disconnect the voltmeter calibrator, and connect the test oscillator and attenuator to the 3410A using the 50Ω oscillator output and 50Ω termination.

f. Set the attenuator to 0 dB attenuation. Set the test oscillator to 400 Hz, and adjust the amplitude controls until the 3410A meter indication is the same as in step d of this paragraph. Set a reference on the test oscillator meter and use the amplitude control to maintain the set reference whenever the frequency of the oscillator is varied.

g. Repeat step d of this paragraph for frequencies 60 Hz through 600 kHz, (listed in Table 5-2) tuning the 3410A to each respective frequency.

h. Set the test oscillator to 10 Hz, and adjust oscillator amplitude to .5 V less than the indication in step d.

i. Tune and lock the 3410A to the 10 Hz signal. Note 3410A meter indication; if not within tolerances listed in Table 5-2, perform meter calibration, Paragraph 5-40.

5-11. 3 MV RANGE.

a. Disconnect the test oscillator and attenuator, and connect the voltmeter calibrator to th 3410A.

b. Set 3410 A controls as follows:

MODE . . . . TUNE
RANGE . . . . 3 MV
FREQUENCY X10
FREQUENCY Dial. 40

c. Set the voltmeter calibrator for a 3 mV rms output at 400 Hz.

d. If necessary, tune the 3410A FREQUENCY Dial until the instrument locks to the signal; then place the MODE switch to READ position.

e. Note the 3410A meter indication; if not within tolerances listed in Table 5-2, perform meter calibration, Paragraph 5-40. Record this indication.

f. Disconnect the voltmeter calibrator and connect the test oscillator and attenuator to the 3410A

g. Set the attenuator to 0 dB attenuation. Set the test oscillator to 400 Hz, and adjust the amplitude controls until the 3410A meter indication is same as in step e of this paragraph. Set a reference on the test oscillator meter, and use the amplitude controls to maintain the set reference whenever the frequency of the oscillator is varied.

h. Repeat step e of this paragraph for frequencies 60 Hz through 600 kHz, (listed in Table 5-2) tuning the 3410A to each respective frequency.

i. Set test oscillator to 10 Hz, and adjust amplitude to .5 mV less than that in step e of this paragraph.

j. Tune and lock the 3410A to the 10 Hz signal. Note the 3410A meter indication; if not within tolerances listed in Table 5-2, perform meter calibration, Paragraph 5-40.

Table 5-2. Meter Tolerances

3V RANGE			3 MV			.003 MV		
FREQ. (Hz)	METER INDICATION MIN.	METER INDICATION MAX.	FREQ. (Hz)	METER INDICATION MIN.	METER INDICATION MAX.	FREQ. (Hz)	METER INDICATION MIN.	METER INDICATION MAX.
10	2.20	2.80	10	2.20	2.80	25	1.90	3.10
60	2.91	3.09	60	2.91	3.09	100	2.20	2.80
400	2.91	3.09	400	2.91	3.09	400	2.91	3.09
1K	2.91	3.09	1K	2.91	3.09	1K	2.91	3.09
10K	2.91	3.09	10K	2.91	3.09	50K	2.91	3.09
100K	2.85	3.15	100K	2.85	3.15	100K	1.90	2.80
600K	2.85	3.15	600K	2.85	3.15	600K	1.90	2.80

5-12. . 003 MV RANGE.

a. Set the 3410A controls as follows:

MODE	TUNE
RANGE	3 MV
FREQUENCY	X10
FREQUENCY Dial	40

b. Set the attenuator to 60 dB attenuation.

c. Set the test oscillator output to 3 V at 400 Hz.

d. If necessary, tune the 3410A FREQUENCY until the instrument locks to the signal; then place the MODE switch to READ position.

e. Adjust the test oscillator amplitude controls until the 3410A meter indication is the same as in step e of Paragraph 5-11. Set a reference on the test oscillator meter, and use the amplitude controls to maintain the set reference whenever the frequency of the oscillator is varied.

f. Set the test oscillator output attenuator to 3 mV range. (The signal applied to the 3410A will be 3 μV, due to the 60 dB of attenuation in the attenuator set).

g. Set the 3410A RANGE switch to . 003 mV.

h. Note 3410A meter indication; if not within tolerances listed in Table 5-2, perform meter calibration, Paragraph 5-40.

i. Repeat step h of this paragraph for frequencies 1K and 50K, (listed in Table 5-2) tuning the 3410A to each respective frequency.

j. Set the test oscillator to 25 Hz, and adjust the oscillator amplitude to . 5 mV less than that in step e of this paragraph. (The signal applied to the 3410A will be 2. 5 μV, due to the 60 dB of attenuation in the attenuator set). Set a reference on the meter of the test oscillator, and use the amplitude controls to maintain the set reference whenever the frequency of the oscillator is varied.

k. Tune and lock the 3410A to 25 Hz signal. Note the 3410A meter indication; if not within tolerances listed in Table 5-2 perform meter calibration, Paragraph 5-40.

l. Repeat step k of this paragraph for frequencies 100 Hz, 100 kHz and 600 kHz, (listed in Table 5-2) tuning the 3410A to each respective frequency.

5-13. PHASE LOCK RANGE CHECK.

5-14. This check requires the following test equipment: Test Oscillator (-hp- Model 652A), Electronics Counter (-hp- Model 5532A), Two Function Generators (-hp- Model 3300A), Sweep-Offset Plug-in (-hp- Model 3304A), Auxiliary Plug-in (-hp- Model 3301), AC-DC Voltmeter (-hp- Model 427A, and 50Ω Feed-through Termination (-hp- Model 11048B).

5-15. PULL-IN CHECK.

a. Connect 3410A OSC OUT terminal to the electronic counter.

b. Set 3410A controls as follows:

MODE	TUNE
RANGE	1 V
FREQUENCY	X1K
FREQUENCY Dial.	10

c. Adjust the 3410A FREQUENCY dial until the electronic counter indicates 10 kHz. Do not readjust the 3410A frequency controls.

d. Disconnect the 3410A from the electronic counter, and connect the 50Ω output of the test oscillator to the counter. (Connect a 50Ω feedthru termination, -hp- Model 11048B between instruments). Set the test oscillator output to 1 V.

e. Adjust the frequency of the test oscillator until electronic counter indicates 9. 4 kHz. Do not readjust the test oscillator frequency controls.

f. Disconnect the test oscillator from the electronic counter, and connect the test oscillator to the 3410A input.

g. The 3410A should lock to the signal and the meter should indicate approximately 1 V. This verifies a phase lock pull in range of 1% of full scale frequency.

h. Disconnect the test oscillator from the 3410A. Set the FREQUENCY dial to 15. The counter indication should be 15 kHz ± 6 kHz.

i. Set the FREQUENCY dial to 50. The counter should read 50 kHz ± 6 kHz.

5-16. TRACKING CHECK.

a. Connect two function generators, the electronic counter and the ac voltmeter as shown in Figure 5-2. (Note that function generator "A" is set up for external frequency control, using output of function generator "B").

b. Set function generator "A" for 1 V sine wave output, as monitored on the ac voltmeter.

c. Set the amplitude of function generator "B" to minimum. Adjust the negative dc offset (on plug-in) to obtain a frequency of 50 kHz from function generator "A", as monitored on the electronic counter.

d. Set function generator "B" for a triangle wave output at . 025 Hz. Monitor generator

"A" output with the electronic counter, and adjust the triangle wave amplitude (generator "B") until function generator "A" is sweeping from 47 kHz to 53 kHz. A full sweep cycle, from 47 kHz to 53 kHz and back to 47 kHz, requires 40 seconds. The frequency thus changes 12 kHz in 40 seconds or 300 Hz in one second. This is equal to 0.5% of full scale per second.

e. Set 3410A controls as follows:

MODE . . . . TUNE
RANGE . . . . 1 V
FREQUENCY X1K
FREQUENCY Dial 50

f. Connect the 3410A to the output of function generator "A". This test verifies that the 3410A will track ± 5% of full scale frequency at a rate of 0.5% of full scale per second.

5-17. INPUT IMPEDANCE CHECK.

5-18. This check requires the following test equipment: Test Oscillator (-hp- Model 652A), 50Ω Feed-through Termination (-hp- Model 11048B), 200 kΩ ± 1% Resistor (-hp- Part No. 0757-0782).

5-19. RESISTANCE CHECK.

a. Connect the 50Ω output of the test oscillator to 3410A using a 50Ω feedthrough termination.

b. Set the 3410A controls as follows:

MODE . . . . TUNE
RANGE 1V
FREQUENCY X10
FREQUENCY Dial. 40

c. Set the test oscillator for a full scale meter deflection of the 3410A at 400 Hz. If necessary, tune the 3410A FREQUENCY dial until the instrument locks to the signal; then place the MODE switch to READ. Record the indication.

d. Connect a 200 kΩ resistor between the test oscillator and the 3410A as shown in Figure 5-3.

e. The 3410A meter indication should not drop more than one small division from full scale. This verifies an input resistance of 10 MΩ.

5-20. CAPACITANCE CHECK.

a. Connect the test oscillator (terminated in 50Ω) and a 200 kΩ resistor to 3410A as shown in Figure 5-3. Insert the resistor lead directly into the BNC connector on the 3410A, and connect the ground lead to the outer shield of the connector. Do not use an adapter, as it would add input capacitance. The 50Ω termination should be as close as possible to the 200 kΩ resistor.

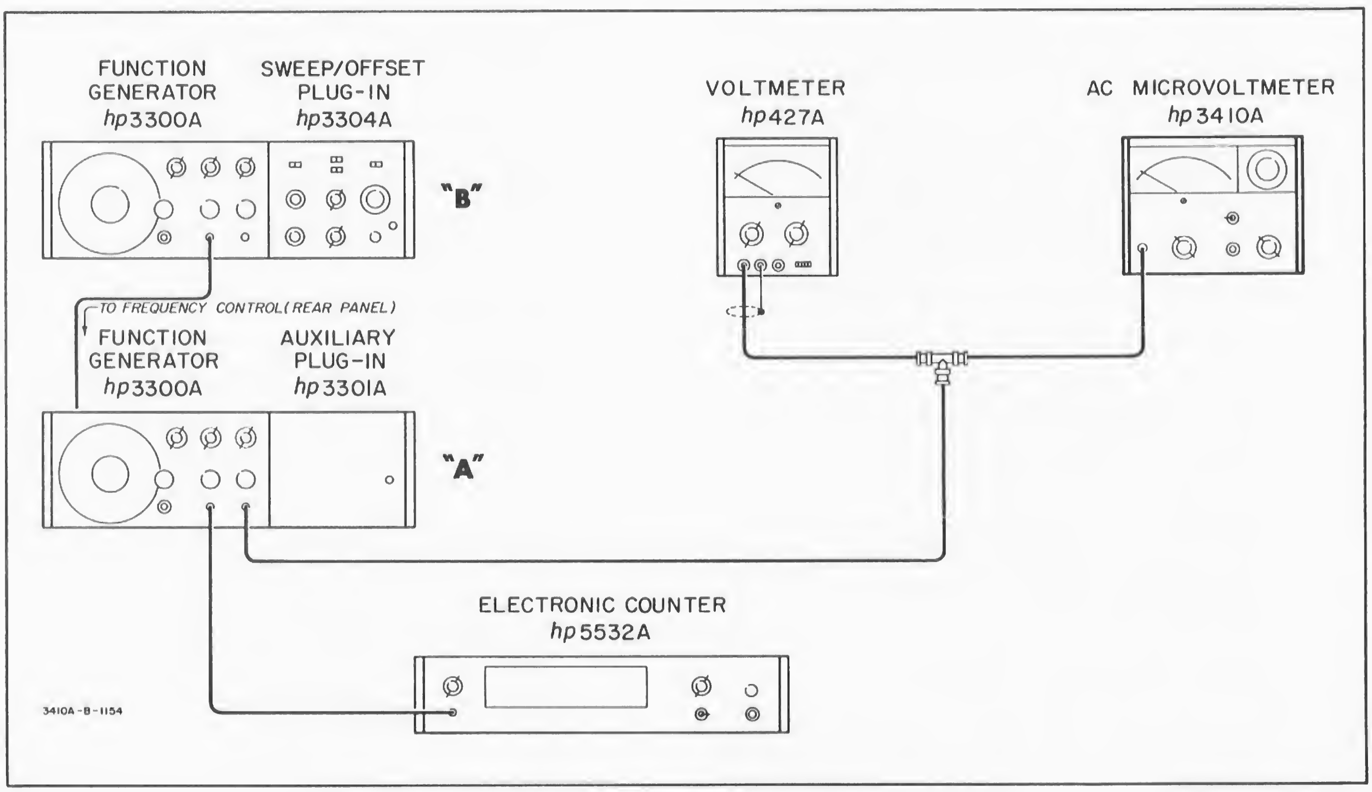


Figure 5-2. Tracking Check

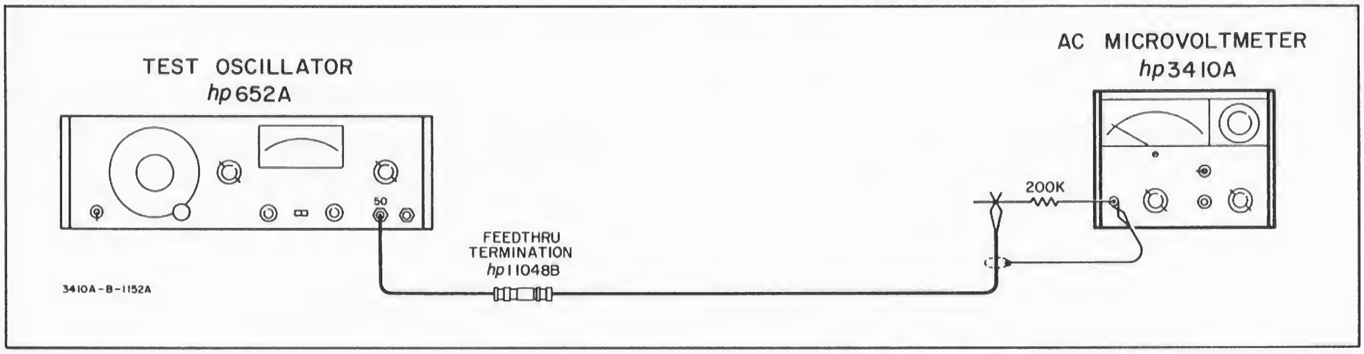


Figure 5-3. Input Impedance Check

b. Set the 3410A controls as follows:

MODE . . . . TUNE
RANGE . . . . 1 MV
FREQUENCY X10
FREQUENCY Dial 40

c. Set the test oscillator for a full scale meter deflection of the 3410A at 400 Hz. If necessary, tune the 3410A FREQUENCY dial until the instrument locks to the signal; then place the MODE switch to READ.

d. Increase the frequency of the test oscillator to 40 kHz; tune and lock the 3410A to the 40 kHz signal. The 3410A meter indication should be 0.707 mV or greater, verifying an input capacitance of 20 pF or less on the 1 mV range.

e. Set the 3410A controls as follows:

MODE . . . . TUNE
RANGE . . . . .01 V
FREQUENCY X10
FREQUENCY Dial. 40

f. Set the test oscillator for a full scale meter deflection of the 3410A at 400 Hz. If necessary, tune the 3410A FREQUENCY dial until the instrument locks to the signal; then place the MODE switch to READ.

g. Increase the frequency of the test oscillator to 80 kHz; tune and lock the 3410A to 80 kHz signal. The 3410A meter indication should be 7.07 mV or greater, verifying an input capacitance of 10 pF or less on the 10 mV range.

5-21. LOCAL OSCILLATOR OUTPUT.

5-22. This check requires the following equipment: Oscilloscope (-hp- Model 140A/1405A), 10:1 Probe (-hp- Model 10001A).

a. Set the 3410A controls as follows:

MODE . . . . TUNE
RANGE . . . . 3 V
FREQUENCY X10K
FREQUENCY Dial 50

b. Connect the OSC OUT to the oscilloscope, using the 10:1 probe. The observed square wave should be greater than four volts peak to peak.

5-23. ADJUSTMENT AND CALIBRATION PROCEDURES.

5-24. The following paragraphs contain a complete adjustment and calibration procedure for the 3410A. This procedure should be performed only if it has been determined by the Performance Checks that the instrument is not operating within specifications. Figure 5-4 shows the location of all internal adjustments and test points.

NOTE

Before beginning the Adjustment and Calibration Procedure, mechanically zero the meter according to the steps in Paragraph 3-7.

5-25. COVER REMOVAL.

5-26. To remove the top or bottom cover, remove the two screws from the back of the cover, slide it about 1/2 inch to the rear, and lift it off. To remove a side cover, remove the four screws from the cover, and lift it off. To replace either cover, reverse the removal procedure.

5-27. POWER SUPPLY VOLTAGE ADJUSTMENT.

5-28. This adjustment requires a DC Voltmeter (-hp- Model 427A).

a. Connect a dc voltmeter to A4TP3.

b. Adjust A4R6 for an indication of +45V ± 0.5V on the dc voltmeter.

c. Connect the dc voltmeter to A4TP2. The voltmeter should indicate between +28.5V and +29.8V. If not, A4CR12 should be replaced. More than one diode may have to be tried to get the proper voltage range.

d. Connect the dc voltmeter to A4TP1.

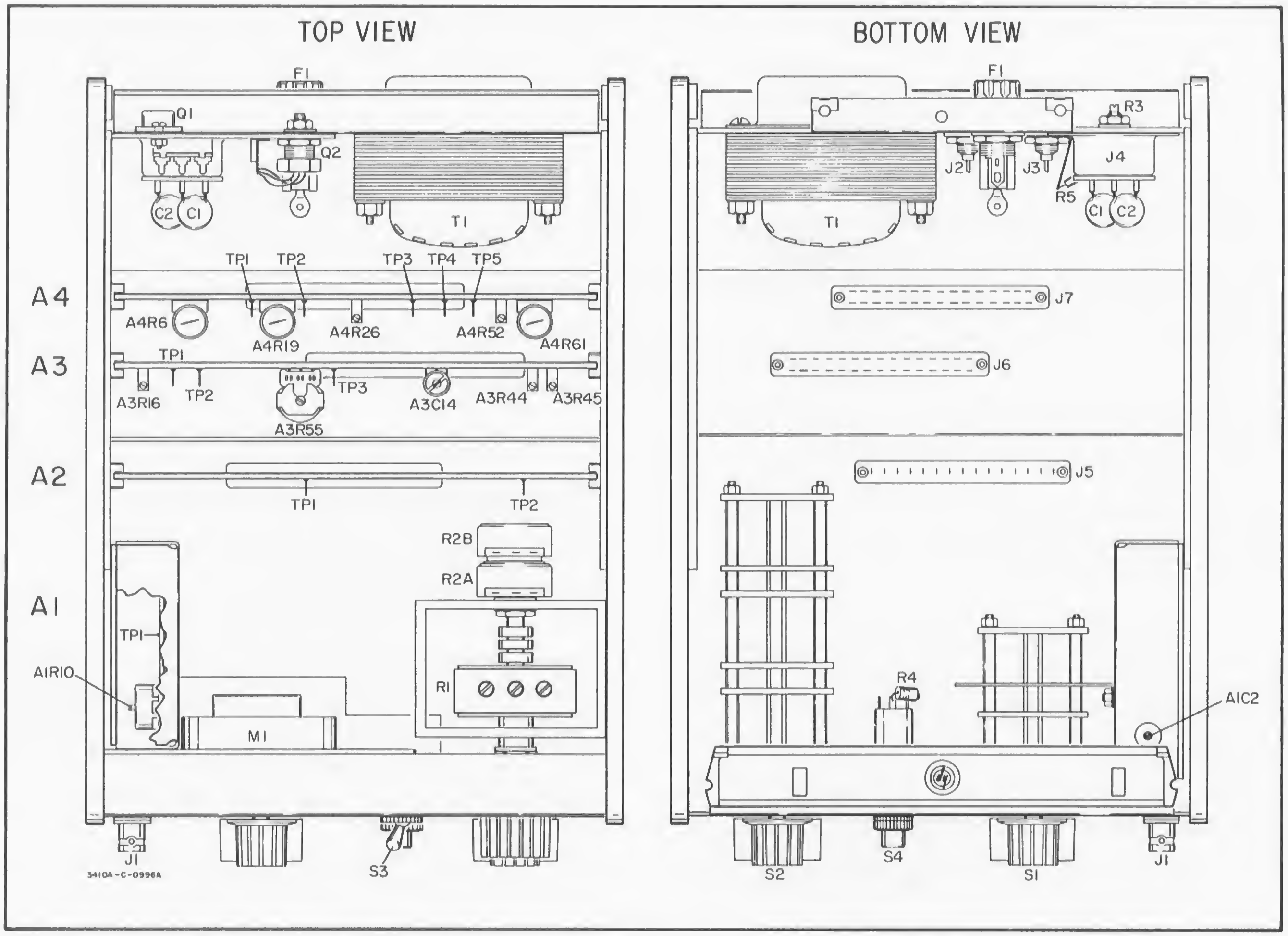


Figure 5-4. Adjustment and Chassis Mounted Components Location

e. Adjust A4R19 for a dc voltmeter indication of -24.8V ± 0.1V.

f. If instrument is operated from high or low line (102V to 128V for 115V line, 204V to 356V for 230V line), the test point readings in the above steps should remain within tolerances.

5-29. PREAMPLIFIER BIAS ADJUSTMENT.

5-30. This adjustment requires a DC Voltmeter (-hp- Model 427A). The bottom cover and side cover adjacent to the INPUT jack must be removed. The shield over the preamplifier board must be removed to perform this adjustment. To remove the shield, remove the four screws in the top and bottom of the shield and lift it off through the side of the instrument. Replace the shield when the adjustment is completed.

a. Connect the dc voltmeter to A1TP1.

NOTE

This is a sensitive adjustment, and 30 seconds should be allowed between adjustments.

b. Adjust A1R10 for a dc voltmeter indication of +5.5V ± 0.5V.

5-31. PHASE LOCK AMPLIFIER BALANCE ADJUSTMENT.

5-32. This adjustment requires a DC Voltmeter (-hp- Model 427A).

a. Set the 3410A FREQUENCY range switch to X100 range and the voltage RANGE switch to the 3 V range with no input signal.

b. Measure the voltage at A3TP1 and A3TP2, referenced to circuit ground.

NOTE

Do not attempt to make a differential measurement between A3TP1 and A3TP2 with a power line operated voltmeter because of grounding problems. Adjust A3R15 until A3TP1 and A3TP2 are within .1V of each other. Allow two minutes for the voltages at A3TP1 and A3TP2 to stabilize. The normal range of voltages at A3TP1 and A3TP2 when balanced is from +2.5V to +3.2V.

5-33. METER MECHANICAL ZERO ADJUSTMENT.

5-34. The 3410A meter is properly zero-set when the meter pointer rests over the zero mark, with the instrument in normal operating position at normal operating temperature and turned off. Adjust zero-set as follows to obtain maximum accuracy and mechanical stability:

a. Turn the instrument on and allow it to operate for 20 minutes to ensure that the meter movement reaches normal operating temperature.

b. Turn the instrument off and allow at least one minute for all capacitors to discharge.

c. Rotate the mechanical zero adjustment screw clockwise until the pointer is left of zero and moving upscale toward zero. Stop when the pointer is exactly on zero; if the pointer overshoots, repeat this step.

d. When the pointer is exactly over zero, rotate the adjustment screw slightly counterclockwise to relieve tension on the pointer suspension. If the pointer moves to the left, repeat the procedure, but make the counterclockwise rotation less.

5-35. METER AND INHIBIT AMPLIFIER BALANCE ADJUSTMENTS.

5-36. This adjustment requires a DC Voltmeter (-hp- Model 427A).

a. Set the MODE switch to READ position.

b. Connect the dc voltmeter to A4TP4.

c. Adjust A4R26 for an indication of +12V ± 0. 5V on the dc voltmeter. This assures that A4Q11 is not conducting, so that the measurement made in the following step will be accurate.

d. Adjust A4R52 for an indication of zero on the 3410A meter.

e. Connect the dc voltmeter to A4TP5; the voltmeter should indicate +15V ± 0. 5V. Record the indication.

f. Connect the dc voltmeter to A4TP4.

g. Adjust A4R26 for a dc voltmeter indication that is 0. 8 V less than that obtained in step e of this paragraph.

NOTE

Do not attempt to make a differential measurement between A4TP4 and A4TP5 with a power line operated voltmeter because of grounding problems.

5-37. VCO FREQUENCY CALIBRATION.

5-38. This adjustment requires an Electronic Counter (-hp- Model 5532A).

a. Connect an electronic counter to the 3410A oscillator output.

b. Set the 3410A controls as follows:

MODE	TUNE
RANGE	1V
FREQUENCY	X100
FREQUENCY Dial	60

c. Adjust A3R44 for an electronic counter indication of 6 kHz ± 180 Hz.

d. Set the 3410A FREQUENCY dial to 5.

e. Adjust A3R45 for an electronic counter indication of 500 Hz ± 50 Hz.

NOTE

The 500 Hz calibration interacts with the 6 kHz calibration. Therefore, it may be necessary to repeat the two adjustments to bring both end frequencies within specifications.

NOTE

If difficulty is encountered in making this adjustment, measure the voltage at the center terminal of the FREQUENCY dial potentiometer and preset A3R44 for a +38V reading at 6 kHz dial setting. Then preset A3R45 for +6V at 500 Hz dial setting. Then repeat steps c through e.

f. Set the FREQUENCY switch to X10K, and set the FREQUENCY dial to 60.

g. Adjust A3C14 for an electronic counter indication of 600 kHz ± 5%.

5-39. METER CALIBRATION.

5-40. This adjustment requires a Voltmeter Calibrator (-hp- Model 738BR) and a Test Oscillator (-hp- Model 652A).

a. Connect the -hp- Model 738BR voltmeter calibrator to Model 3410A.

b. Set the 3410A controls as follows:

MODE	TUNE
RANGE	3 MV
FREQUENCY	X10
FREQUENCY Dial	40

c. Set the voltmeter calibrator for a 3 mV rms output at 400 Hz.

d. If necessary, tune the 3410A FREQUENCY dial until the instrument locks to the signal; then place the MODE switch to READ position.

e. Adjust A4R61 for a 3410A meter indication of 3.0 mV.

f. Disconnect the -hp- Model 738BR voltmeter calibrator and connect the 50 ohm output of the Model 652A Test Oscillator to the 3410A. Set the Test Oscillator to 400 Hz and adjust the amplitude controls until the 3410A meter indicates 3.0 mV. Set a reference on the Test Oscillator meter, and use the amplitude control to maintain the set reference whenever the frequency of the oscillator is varied.

g. Set the Test Oscillator to 50 Hz, 300 Hz, and 600 Hz, tuning the 3410A to each respective frequency. If the meter indication for each frequency is not between 2.91 and 3.09 adjust A4R61 to split the difference in error across the X10 frequency range.

5-41. <u>600 kHz METER ZERO.</u>

5-42. This adjustment requires a DC Voltmeter (-hp- Model 427A).

a. Set the 3410A MODE switch to READ position, VOLTAGE range to the 3 mV, and the FREQUENCY controls to 600 kHz with no input signal.

b. Adjust A3R55 for a zero indication on the meter.

c. Set the 3410A to TUNE mode and check the voltages at A4RP4 and A4TP5 for the same voltage relationship as in the Meter and Inhibit Amplifier Balance Adjustment (app. .8 V higher at A4TP5 than A4TP4).

d. If the A4TP4 and A4TP5 voltage relationship is not the same as stated in step c, slightly readjust A3R55 for the .8V ± .2V reading.

e. Check the zero at 300 kHz and split the error with A3R55 and still maintain approximately .8V higher at A4TP5 than at A4TP4.

5-43. <u>POST AMPLIFIER RESPONSE.</u>

5-44. This adjustment requires a Test Oscillator (-hp- Model 652A).

a. Set the 3410A controls as follows:

MODE	TUNE
RANGE	3 MV
FREQUENCY	X10
FREQUENCY Dial	40

b. Set the Test Oscillator for a 3 mV output at 400 Hz.

c. Connect the Test Oscillator to the 3410A input using a 50 ohm load.

d. Adjust the oscillator output for a 30 mV reading on the 3410A and set a reference on the Test Oscillator.

e. Set the frequency controls on both instruments to 300 kHz. The 3410A meter should indicate between 2.85 mV and 3.15 mV.

f. Set the frequency controls on both instruments to 600 kHz. The 3410A meter should indicate between 2.85 mV and 3.15 mV.

5-45. The response at both 300 kHz and 600 kHz may be increased by decreasing the value of A1C1*. The change at 600 kHz is greater than that at 300 kHz. Additional response increase at 600 kHz may be obtained by decreasing the value of A1C10*.

5-46. <u>PREATTENUATOR FLATNESS ADJUSTMENT.</u>

5-47. This adjustment requires a Test Oscillator (-hp- Model 652A) and a 50Ω feedthrough termination (-hp- 11048B).

a. Connect the 50Ω output of Test Oscillator to 3410A using the 50Ω feedthrough termination. (-hp-

b. Set the 3410A controls as follows:

MODE	TUNE
RANGE	3 MV
FREQUENCY	X10K
FREQUENCY Dial.	60

c. Set the Test Oscillator to 600 kHz and set the output attenuator to the 3 mV range. Adjust the oscillator amplitude controls for a 3 mV output on the oscillator meter.

d. If necessary, tune the 3410A FREQUENCY dial until instrument locks to signal; then place the MODE switch to READ position.

e. Adjust the Test Oscillator amplitude controls for a 3410A meter indication of 3 mV.

f. Set the 3410A RANGE switch to 3 V and set the Test Oscillator output attenuator to 3 V. Do not readjust Test Oscillator amplitude controls.

g. Adjust A1C2 for a 3410A meter indication of 3 V.

h. Check the ranges 1 V through .01 V. If, on any range, the error on 3410A is greater than ± 5% of F. S., split the error using A1C2.

i. Repeat steps c through h at 300 kHz and 50 kHz (5 X10K). If any error on the 3410A is greater than ± 5% of F. S., split the error using A1C2 among all ranges and frequencies.

5-48. TROUBLESHOOTING PROCEDURES.

5-49. FRONT PANEL TROUBLESHOOTING.

5-50. Refer to Figure 5-5, Front Panel Troubleshooting Tree, and Figure 4-0, Simplified Block Diagram, for this procedure; which is applicable when it is not possible to obtain a meter indication on the 3410A.

(1) Apply an input signal equal to full scale on an upper 3410A voltage range. Downrange the 3410A voltage RANGE switch 20 dB below the input signal level. The RANGE INDICATOR should glow. If not, troubleshoot the Input Circuit, Paragraph 7-6. (7)

(2) If the RANGE INDICATOR does light, switch out the Inhibit Circuit by placing the MODE switch in READ position. Try to obtain a meter indication by slowly tuning the frequency dial back and forth.

(3) If the meter responds to the signal, there is trouble in the Inhibit Circuit. Refer to Paragraph 7-14.

(4) If there is no meter deflection, connect an electronic counter or oscilloscope to the OSC OUT jack on the 3410A rear panel. Observe the counter or oscilloscope while varying the frequency around the input frequency. The Local Oscillator should lock to the input.

(5) If the 3410A locks to the input signal, there is trouble in the Meter Circuit. Refer to Paragraph 7-16.

(6) If the 3410A will not lock to the input signal, there is trouble in the Phase Lock Loop. Refer to Paragraph 7-10.

5-51. REPAIR PROCEDURES.

5-52. PROCEDURE FOR REPLACING R1 AND R2.

5-53. DISASSEMBLY OF 3410A.

1. Remove all covers.
2. Remove left side gusset (side gusset near the frequency tuning dial).
3. Remove screw holding meter trim on right side gusset and slide off meter trim (refer to Figure 6-1 in Operating and Service Manual).
4. Replace left side gusset with sufficient screws to hold the left side gusset and bracket for R1 and R2 in place.

5-54. CALIBRATING DIAL TO R1.

1. Loosen set screws number 1 and 2 on collar of dial assembly.
2. Rotate dial to 60 and adjust resistance of R1 between contacts 3 and 4 for approximately 700 ohms (shaft at the rear of potentiometer is a convenient place to rotate R1). Tighten set screw number 1.
3. Rotate dial to 25 and check resistance between contacts 3 and 4. Resistance should read between 6 K and 6.2 K.

5-55. CALIBRATING DIAL TO R2.

1. Loosen set screws 5 and 6 on forward coupler connecting R1 to R2.
2. Rotate dial to 5 and adjust resistance of R2 between contacts 7 and 8 for 33 K (shaft coupler on R2 is a convenient place to rotate

INITIAL CONDITIONS:

MODE Switch	TUNE
FREQ Dial	40
FREQUENCY	X10
VOLTAGE RANGE	1V
Input Signal	1V rms, 400 Hz

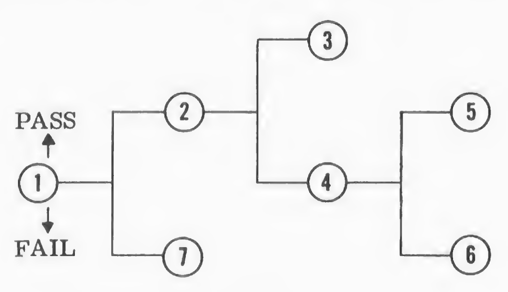


Figure 5-5. Front Panel Troubleshooting

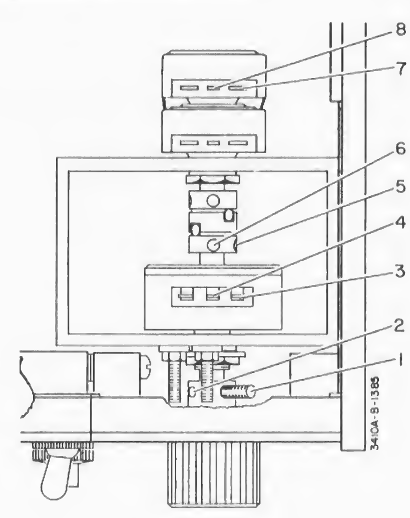


Figure 5-6. R1 and R2 Replacement

R2). Tighten either set screw 5 or 6, whichever is convenient.

3. Rotate dial to extreme CCW position. Set screw 1 should hit the upper stop (9).

4. If set screw 1 does not hit the upper stop (9), loosen set screw tightened in step 2 and rotate dial until it hits the stop. Then tighten either set screw 5 or 6, whichever is convenient. Recheck the resistance between contact 7 and 8 for 26.4 K to 39.6 K on 5 on dial. If out of test limit, replace R2.

5. Tighten set screws 5 and 6.

5-56. REASSEMBLY OF 3410A.

1. Remove left side gusset being held on by a few screws.

2. Replace meter trim by sliding it over meter and replace screw holding the meter trim to right side gusset.

3. Replace the left side gusset and replace all screws holding the left side gusset.

4. Replace all covers.

5-57. SERVICING ETCHED CIRCUIT BOARDS.

5-58. The Model 3410A contains four plated-through, double-sided, etched circuit boards. When working on these boards, observe the following rules to prevent damage to the circuit board or components:

a. Use a low-heat (25 to 50 watts) soldering iron with a small tip.

b. To remove a component, clip a heat sink (long nose pliers, commercial heat sink tweezers, etc.) on the component lead as close to the component as possible. Place the soldering iron directly on the component lead, and pull up on the lead. If a component is obviously damaged or faulty, clip the leads close to the component, and remove the leads from the board.

CAUTION

EXCESSIVE OR PROLONGED HEAT CAN LIFT THE CIRCUIT FOIL FROM THE BOARD OR CAUSE DAMAGE TO COMPONENTS.

c. Clean the component lead holes by heating the solder in the hole, quickly removing the soldering iron, and inserting a pointed, nonmetallic object such as a toothpick.

d. To mount a new component, shape the leads and insert them in the holes. Clip a heat sink on the component, heat with the soldering iron, and add solder as necessary to obtain a good electrical connection.

5-60. SERVICING ROTARY SWITCHES.

5-61. The Model 3410A contains two rotary type switches: FREQUENCY and RANGE. When working on these switches, observe the following rules:

a. Use a low heat (25 to 50 watts) soldering iron with a small tip.

b. When replacing components, attempt to dress them as nearly to their original alignment as possible.

c. Clean excessive flux from the connection and adjoining area.

d. After cleaning the switch, apply a light coat of lubriplate to the switch detent balls. DO NOT apply lubricant to switch contacts or allow lubricant to contaminate components.

Table 5-3. Factory Selected Components

COMPONENT	MOST COMMON VALUE	EFFECT UPON CIRCUIT
A2C1*	1000 pF	Decrease value to increase broadband response
A2C10*	2.0 pF	Decrease value to increase 600 kHz response

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 3410A
AC Microvoltmeter
Serial No. ______________

Tests performed by ______________
Date ______________

1. ACCURACY AND FREQUENCY RESPONSE:	METER INDICATION:	Min.	Max.
3V Range			
10 Hz	☐	2.20	2.80
60 Hz	☐	2.91	3.09
400 Hz	☐	2.91	3.09
1 kHz	☐	2.91	3.09
10 kHz	☐	2.91	3.09
100 kHz	☐	2.85	3.15
600 kHz	☐	2.85	3.15
3 mV Range			
10 Hz	☐	2.20	2.80
60 Hz	☐	2.91	3.09
400 Hz	☐	2.91	3.09
1 kHz	☐	2.91	3.09
10 kHz	☐	2.91	3.09
100 kHz	☐	2.85	3.15
600 kHz	☐	2.85	3.15
.003 mV Range			
25 Hz	☐	1.90	3.10
100 Hz	☐	2.20	2.80
400 Hz	☐	2.91	3.09
1 kHz	☐	2.91	3.09
50 kHz	☐	2.91	3.09
100 kHz	☐	2.20	2.80
600 kHz	☐	2.20	2.80

2. PHASE LOCK RANGE:	
Pull in	☐ 1% full scale
Tracking	☐ 5% full scale at 0.5%
	☐ full scale per second

3. INPUT IMPEDANCE:	
Resistance	☐ 10 MΩ or greater
Capacitance	☐ 20 pF or less, .003 mV to 3 mV
	☐ 10 pF or less, 10 mV to 3 V

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (TQ column). The total quantity of a part is given the first time the part number appears.

b. Descriptions of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.) Parts that are manufactured by Hewlett-Packard are identified by the abbreviation -hp-.

d. Manufacturer's part number.

6-3. Figure 6-1 illustrates the modular cabinet parts, and Figure 6-2 illustrates the replaceable mechanical parts used in the 3410A. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix B for list of office locations.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

DESIGNATORS

A	= assembly	F	= fuse	MP	= mechanical part	TC	= thermocouple
B	= motor	FL	= filter	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
BT	= battery	HR	= heater	Q	= transistor	W	= cable
C	= capacitor	IC	= integrated circuit	QCR	= transistor-diode	X	= socket
CR	= diode	J	= jack	R	= resistor	XDS	= lampholder
DL	= delay line	K	= relay	RT	= thermistor	XF	= fuseholder
DS	= lamp	L	= inductor	S	= switch	Z	= network
E	= misc electronic part	M	= meter	T	= transformer		

ABBREVIATIONS

Ag	= silver
Al	= aluminum
A	= ampere (s)
Au	= gold
C	= capacitor
cer	= ceramic
coef	= coefficient
com	= common
comp	= composition
conn	= connection
dep	= deposited
DPDT	= double-pole double-throw
DPST	= double-pole single-throw
elect	= electrolytic
encap	= encapsulated
F	= farad (s)
FET	= field effect transistor
fxd	= fixed
GaAs	= gallium arsenide
GHz	= gigahertz = 10^{+9} hertz
gd	= guard (ed)
Ge	= germanium
grd	= ground (ed)
H	= henry (ies)
Hg	= mercury
Hz	= hertz (cycle (s) per second)
ID	= inside diameter
impg	= impregnated
incd	= incandescent
ins	= insulation (ed)
kΩ	= kilohm (s) = 10^{+3} ohms
kHz	= kilohertz = 10^{+3} hertz
L	= inductor
lin	= linear taper
log	= logarithmic taper
m	= milli = 10^{-3}
mA	= milliampere (s) = 10^{-3} amperes
MHz	= megahertz = 10^{+6} hertz
MΩ	= megohm (s) = 10^{+6} ohms
met flm	= metal film
mfr	= manufacturer
mtg	= mounting
mV	= millivolt (s) = 10^{-3} volts
μ	= micro = 10^{-6}
μV	= microvolt (s) = 10^{-6} volts
my	= Mylar ®
nA	= nanoampere (s) = 10^{-9} amperes
NC	= normally closed
Ne	= neon
NO	= normally open
NPO	= negative positive zero (zero temperature coefficient)
ns	= nanosecond (s) = 10^{-9} seconds
nsr	= not separately replaceable
Ω	= ohm (s)
obd	= order by description
OD	= outside diameter
p	= peak
pc	= printed circuit
pF	= picofarad (s) = 10^{-12} farads
piv	= peak inverse voltage
p/o	= part of
pos	= position (s)
poly	= polystyrene
pot	= potentiometer
p-p	= peak-to-peak
ppm	= parts per million
prec	= precision (temperature coefficient, long term stability, and/or tolerance)
R	= resistor
Rh	= rhodium
rms	= root-mean-square
rot	= rotary
Se	= selenium
sect	= section (s)
Si	= silicon
sl	= slide
SPDT	= single-pole double-throw
SPST	= single-pole single-throw
Ta	= tantalum
TC	= temperature coefficient
TiO_2	= titanium dioxide
tog	= toggle
tol	= tolerance
trim	= trimmer
TSTR	= transistor
V	= volt (s)
vacw	= alternating current working voltage
var	= variable
vdcw	= direct current working voltage
W	= watt (s)
w/	= with
wiv	= working inverse voltage
w/o	= without
ww	= wirewound
*	= optimum value selected at factory, average value shown (part may be omitted)
**	= no standard type number assigned (selected or special type)

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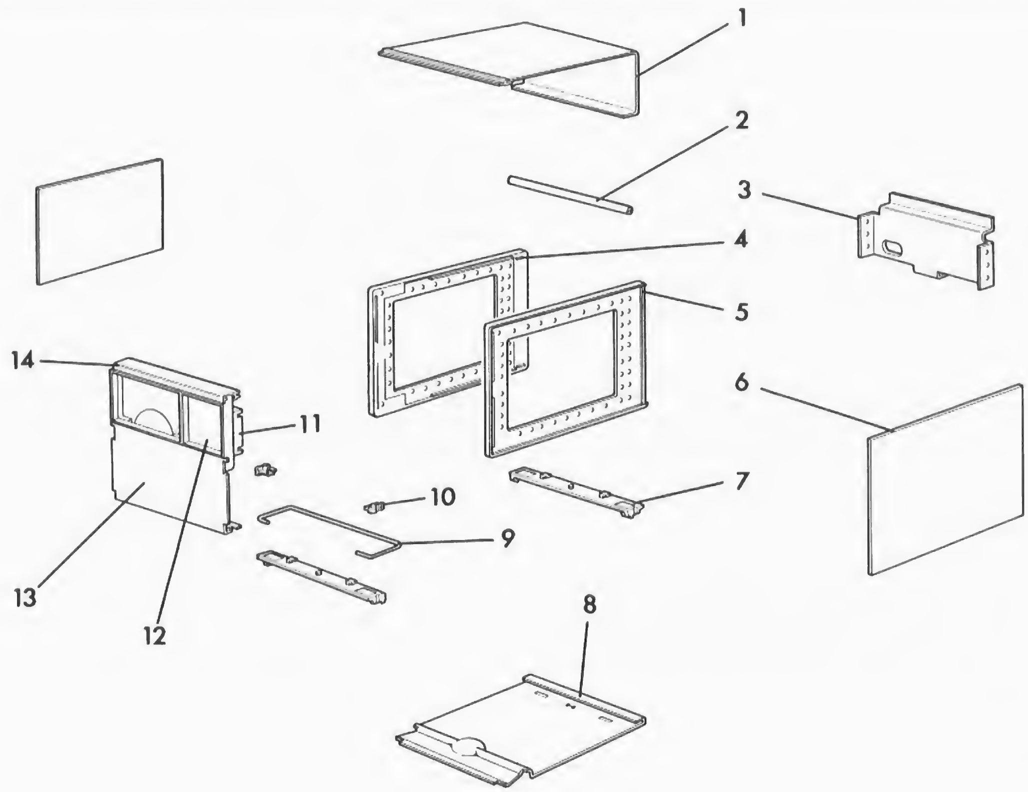
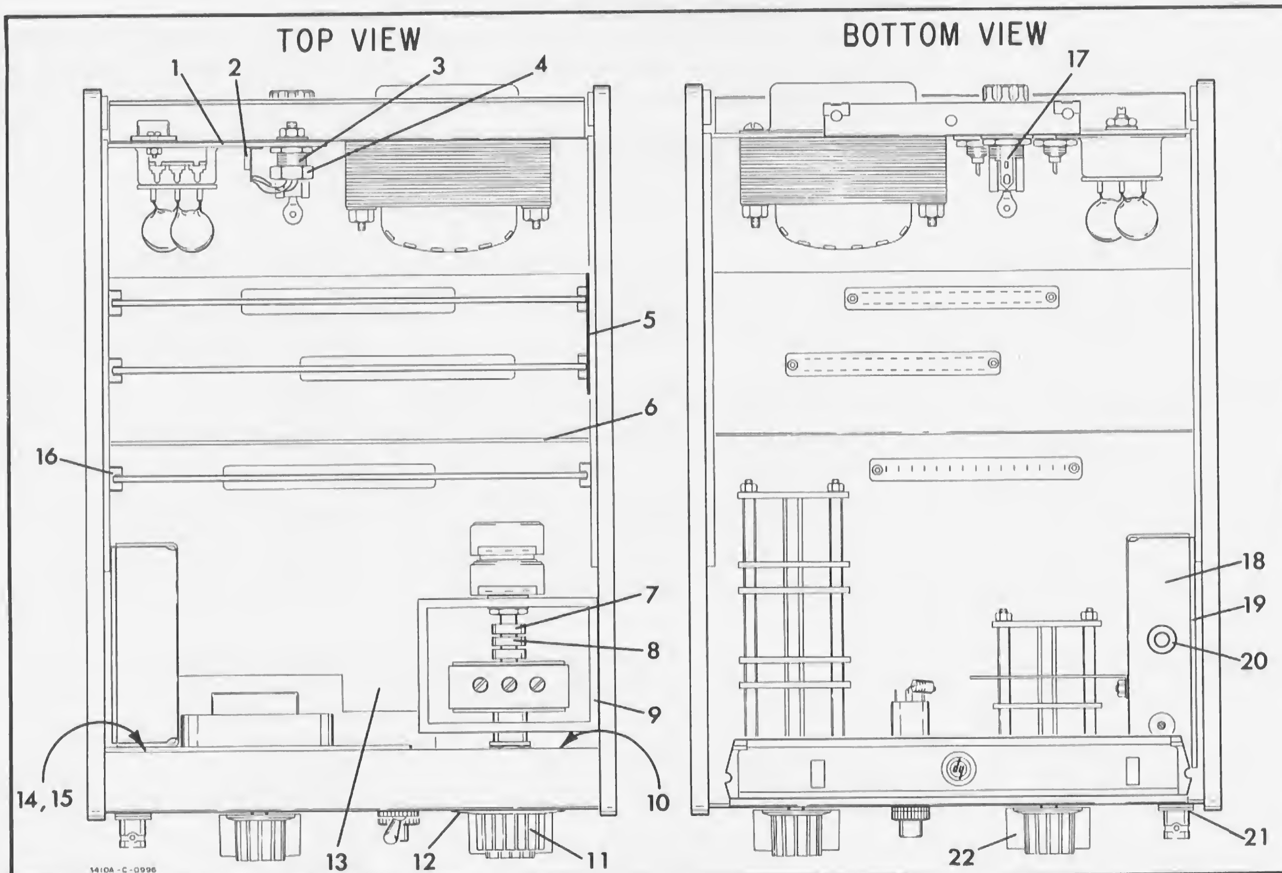


INDEX NO.	-hp- PART NO.	TQ	DESCRIPTION
1	5060-0718	1	Top Cover Assembly
2	5020-0701	2	Cab Spacer-Half Mod.
3	03410-00202	1	Panel-Rear
4	5060-0703	1	Frame Assembly
5	5060-0703	1	Frame Assembly
6	5000-0703	2	Side Cover
7	5060-0728	2	Foot Assembly-Half Mod
8	5000-0717	1	Bottom Cover
9	1490-0032	1	Stand Tilt
10	5040-0700	2	Hinge
11	5040-0697	1	Extender-Meter Case
12	03410-04301	1	Panel-Insert
13	03410-00201	1	Panel-Front
14	5020-5367	1	Meter Trim-Half Mod

Figure 6-1. Modular Cabinet Parts



INDEX NO.	-hp- PART NO.	TQ	DESCRIPTION
1	03410-00105	1	Chassis-Rear
2	0360-1327	1	Terminal Board
3	1205-0008	1	Heat Dissipator
4	1205-0007	1	Heat Dissipator-Nut
5	03410-01201	1	Bracket Guide
6	03410-00102	1	Deck-Rear
7	1500-0005	2	Coupler-Hub
8	1500-0004	1	Coupler-Insulator
9	03410-21201	1	Bracket-Pot Mtg. Freq. Contr.
10	1500-0051	1	Ball Drive 6:1
11	0370-0028	1	Knob-1 In.
12	03410-04001	1	Dial-Frequency
13	03410-00101	1	Deck-Front
14	5040-0235	1	Lamp Holder-Base
15	5040-0234	1	Lamp Holder-Lens
16	5040-0601	6	P. C. Board Guide
17	1400-0084	1	Fuse Post
18	03410-00103	1	Chassis-Preamp
19	03410-00106	1	Shield
20	0340-0060	9	Insulator-Feed Thru
21	5040-0425	4	Washer Insulator
22	0370-0112	2	Knob-Bar

Figure 6-2. Mechanical Parts

Table 6-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	03410-66501		1	Assembly: Preamplifier Board, includes: C1 thru C15 L1 thru L2 CR1 thru CR4 Q1 thru Q3 K1 thru K2 R1 thru R21	-hp-	
A1C1	0150-0096		1	C: fxd cer 0.05 μF +80% -20% 100 vdcw	72982	845-X5V-503Z
A1C2	0132-0003		1	C: var 0.7 to 3 pF	72982	535-016-4R
A1C3	0140-0179		1	C: fxd mica 1000 pF ±2%	04062	RDM19F102G3C
A1C4	0140-0156		1	C: fxd mica 1500 pF ±2%	04062	RDM19F152G3C
A1C5, A1C6	0150-0093		4	C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
A1C7	0160-0170		1	C: fxd cer 22 μF +80% -20% 25 vdcw	56289	5C9BS-CML obd
A1C8	0180-0224		2	C: fxd Al elect 10 μF +75% -10% 15 vdcw	56289	D32441
A1C9	0180-0354		4	C: fxd Ta elect 40 μF ±5% 10 vdcw	56289	150D406X5010B2
A1C10, A1C11	0140-0198		2	C: fxd mica 200 pF ±5%	04062	RDM15F201J3C
A1C12	0180-0224			C: fxd Al elect 10 μF +75% -10% 15 vdcw	56289	30D106G015BA4
A1C13, A1C14	0180-0100		9	C: fxd Ta elect 4.7 μF ±10% 35 vdcw	56289	150D475X9035B2
A1C15	0180-0060		1	C: fxd Al elect 200 μF +75% -10% 3 vdcw	56289	30D207G003CC2-DSM
A1CR1, A1CR2	1901-0025		22	Diode: Si breakdown 100 wiv 15 pF 100 mA	82219	D3072
A1CR3, A1CR4	1901-0044		2	Diode: Si 20 mA/+1 V: 10 NA at -10 V/50 wiv 2 pF; 6 ns	03877	SG 5178 obd
A1K1, A1K2	0490-0343		3	Reed relay: sealed dry reed	-hp-	
A1L1, A1L2	9140-0047		2	Inductor: 20 μH ±10% 2.5 MHz	99848	H51074020
A1Q1	1855-0033		1	TSTR: FET Si N channel	83740	obd
A1Q2, A1Q3	1853-0036		14	TSTR: Si PNP 2N3906	04713	2N3906-5
A1R1	0698-4128		1	R: fxd prec met flm 10.0 MΩ ±1/4% 1/2 W	56289	420E T-2 obd
A1R2	0698-5441		1	R: fxd prec met flm 10.01 kΩ ±1/4% 1/8 W	75042	CEA T-2 obd
A1R3	0683-0625		1	R: fxd comp 6.2 Ω ±5% 1/4 W	01121	CB 6225
A1R4 thru A1R6	0683-3015		3	R: fxd comp 300 Ω ±5% 1/4 W	01121	CB 3015
A1R7, A1R8	0683-1635		2	R: fxd comp 16 kΩ ±5% 1/4 W	01121	CB 1635
A1R9	0683-2745		2	R: fxd comp 270 kΩ ±5% 1/4 W	01121	CB 2745
A1R10	2100-0094		1	R: var comp lin 50 kΩ ±30%	71450	URM70RE (hp)
A1R11	0683-2045		1	R: fxd comp 200 kΩ ±5% 1/4 W	01121	CB 2045
A1R12	0683-2265		1	R: fxd comp 22 MΩ ±5% 1/4 W	01121	CB 2265
A1R13	0683-1535		4	R: fxd comp 15 kΩ ±5% 1/4 W	01121	CB 1535
A1R14	0683-4725		2	R: fxd comp 4700 Ω ±5% 1/4 W	01121	CB 4725
A1R15	0698-5438		1	R: fxd prec met flm 100 Ω ±1/4% 1/8 W	75042	CEA T-2 obd
A1R16	0698-5439		1	R: fxd prec met flm 1000 Ω ±1/4% 1/8 W	75042	CEA T-2 obd
A1R17	0683-3915		1	R: fxd comp 390 Ω ±5% 1/4 W	01121	CB 3915
A1R18	0683-5635		2	R: fxd comp 56 kΩ ±5% 1/4 W	01121	CB 5635
A1R19	0683-4735		1	R: fxd comp 47 kΩ ±5% 1/4 W	01121	CB 4735
A1R20	0683-7505		1	R: fxd comp 75 Ω ±5% 1/4 W	01121	CB 7505
A1R21	0683-5625		1	R: fxd comp 5600 Ω ±5% 1/4 W	01121	CB 5625
A2	03410-66512		1	Assembly: Pc Board, includes: C1 thru C15 Q1 thru Q14 CR1 thru CR7 R1 thru R34 L1 thru L4	-hp-	
A2C1	0160-0938		3	C: fxd mica 1000 pF ±5%	72136	obd
A2C2, A2C3	0180-0100			C: fxd Ta elect 4.7 μF ±10% 35 vdcw	56289	150D475X9035B2
A2C4	0180-0294		1	C: fxd Ta elect 390 μF ±20% 10 vdcw	56289	109D397X0010T2
A2C5	0180-0100			C: fxd Ta elect 4.7 μF ±10% 35 vdcw	56289	150D475X9035B2

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2C6	0160-0938			C: fxd mica 1000 pF ±5%	72136	obd
A2C7	0160-0362		2	C: fxd mica 510 pF ±5%	04062	RDM15F511J3C
A2C8	0160-0938			C: fxd mica 1000 pF ±5%	72136	obd
A2C9	0180-0091		1	C: fxd Al elect 10 μF +50% -10% 100 vdcw	56289	30D106F100DC2-DSM
A2C10	0150-0031		1	C: fxd TiO_2 2.0 pF ±5% 500 vdcw	78488	obd
A2C11	0180-0119		1	C: fxd Al elect 1.0 μF +75% -10% 25 vdcw	56289	5C13C obd
A2C12	0180-1846		1	C: fxd Ta elect 2.2 μF ±10% 35 vdcw	56289	150D225X9035B2-DYS
A2C13	0180-0033		1	C: fxd Al elect 50 μF +100% -10% 6 vdcw	56289	30D506G006CB2-DSM
A2C14	0180-0155		1	C: fxd Ta elect 2.2 μF ±20% 20 vdcw	56289	150D225X0020A2-DYS
A2C15	0180-0269		1	C: fxd Al elect 1 μF +75% -10% 150 vdcw	56289	30D105G150BA2-DSM
A2CR1 thru A2CR7	1901-0025			Diode: Si breakdown 100 wiv 15 pF 100 mA	82219	D3072
A2L1 thru A2L3	9140-0118		3	Inductor: 500 μH ±5%	82142	10178-8
A2L4	9140-0179		1	Inductor: 22 μH ±10%	07261	15-4445-7J
A2Q1, A2Q2	1854-0215		5	TSTR: Si NPN 2N3904	04713	obd
A2Q3	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906-5
A2Q4	1854-0215			TSTR: Si NPN 2N3904	04713	obd
A2Q5	1854-0092		1	TSTR: Si NPN 2N3563	04713	MPS3653
A2Q6	1854-0039		4	TSTR: Si NPN 2N3053	04713	2N3053 obd
A2Q7	1853-0015		1	TSTR: Si PNP 2N3640	04713	MPS3640-5
A2Q8	1853-0012		2	TSTR: Si PNP 2N2904A	04713	2N2904A
A2Q9	1854-0039			TSTR: Si NPN 2N3053	04713	2N3053 obd
A2Q10	1853-0012			TSTR: Si PNP 2N2904A	04713	2N2904A
A2Q11 thru A2Q13	1854-0022		11	TSTR: **	-hp-	
A2Q14	1854-0215			TSTR: Si NPN 2N3904	04713	obd
A2R1	0683-7515		2	R: fxd comp 750 Ω ±5% 1/4 W	01121	CB 7515
A2R2	0683-3905		2	R: fxd comp 39 Ω ±5% 1/4 W	01121	CB 3905
A2R3	0683-3035		1	R: fxd comp 30 kΩ ±5% 1/4 W	01121	CB 3035
A2R4	0683-1235		3	R: fxd comp 12 kΩ ±5% 1/4 W	01121	CB 1235
A2R5	0757-0410		2	R: fxd met flm 301 Ω ±1%	91637	MFF 1/8 T-1 obd
A2R6	0757-0454		2	R: fxd met flm 33.2 kΩ ±1% 1/8 W	75042	CEA T-0 obd
A2R7	0683-7525		1	R: fxd comp 7500 Ω ±5% 1/4 W	01121	CB 7525
A2R8	0757-0410			R: fxd met flm 301 Ω ±1%	91637	MFF 1/8 T-1 obd
A2R9	0683-5635			R: fxd comp 56 kΩ ±5% 1/4 W	01121	CB 5635
A2R10	0683-1035		9	R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
A2R11	0683-2235		3	R: fxd comp 22 kΩ ±5% 1/4 W	01121	CB 2235
A2R12	0683-1015		2	R: fxd comp 100 Ω ±5% 1/4 W	01121	CB 1015
A2R13	0683-2025		3	R: fxd comp 2000 Ω ±5% 1/4 W	01121	CB 2025
A2R14	0683-7515			R: fxd comp 750 Ω ±5% 1/4 W	01121	CB 7515
A2R15	0683-4705		3	R: fxd comp 47 Ω ±5% 1/4 W	01121	CB 4705
A2R16	0683-5125		3	R: fxd comp 5100 Ω ±5% 1/4 W	01121	CB 5125
A2R17	0683-1015			R: fxd comp 100 Ω ±5% 1/4 W	01121	CB 1015
A2R18	0683-3935		2	R: fxd comp 39 kΩ ±5% 1/4 W	01121	CB 3935
A2R19	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
A2R20, A2R21	0683-4705			R: fxd comp 47 Ω ±5% 1/4 W	01121	CB 4705
A2R22	0757-0454			R: fxd met flm 33.2 kΩ ±1% 1/8 W	75042	CEA T-0 obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2R23, A2R24	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
A2R25	0683-5115		4	R: fxd comp 510 Ω ±5% 1/4 W	01121	CB 5115
A2R26	0683-1235			R: fxd comp 12 kΩ ±5% 1/4 W	01121	CB 1235
A2R27	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
A2R28	0683-1235			R: fxd comp 12 kΩ ±5% 1/4 W	01121	CB 1235
A2R29	0683-3925		9	R: fxd comp 3900 Ω ±5% 1/4 W	01121	CB 3925
A2R30	0757-0401		4	R: fxd prec met flm 100 Ω ±1% 1/8 W	75042	CEA T-0 obd
A2R31	0757-0339		1	R: fxd prec met flm 3010 Ω ±1% 1/4 W	19701	MF6C T-0 obd
A2R32	0683-2035		1	R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
A2R33	0683-3935			R: fxd comp 39 kΩ ±5% 1/4 W	01121	CB 3935
A2R34	0757-0831		1	R: fxd prec met flm 4320 Ω ±1% 1/2 W	01121	CB 0831
A3	03410-66503		1	Assembly: Phase Lock Board, includes: C1 thru C22 Q1 thru Q26 CR1 thru CR18 R1 thru R67 IC1 thru IC2	-hp-	
A3C1, A3C2	0150-0084		2	C: fxd cer 0.1 μF +80% -20% 50 vdcw	56289	33C41 obd
A3C3	0180-0137		3	C: fxd Ta elect 100 μF ±20% 10 vdcw	56289	150D107X0010R2
A3C4	0160-2201		2	C: fxd mica 51 pF ±5%	04062	RDM15E510J3C
A3C5				Not assigned		
A3C6	0180-0100			C: fxd Ta elect 4.7 μF ±10% 35 vdcw	56289	150D475X9035B2-DYS
A3C7	0160-0362			C: fxd mica 510 pF ±5%	04062	RDM15F511J3C
A3C8	0140-0145		2	C: fxd mica 22 pF ±5%	04062	RDM15C220J5C
A3C9, A3C10	0150-0050		5	C: fxd cer 1000 pF 600 vdcw	18486	Type E obd
A3C11	0180-0309		1	C: fxd Ta elect 4.7 μF ±20% 10 vdcw	56289	150D475X0010A2-DYS
A3C12	0160-2201			C: fxd mica 51 pF ±5%	04062	DDM15E510J3C
A3C13	0180-0100			C: fxd Ta elect 4.7 μF ±10% 35 vdcw	56289	150D475X9035B2-DYS
A3C14	0121-0105		1	C: var cer 9-35 pF N650	72982	538-006 E2PO 94R
A3C15				Not assigned		
A3C16	0140-0145			C: fxd mica 22 pF ±5%	04062	RDM15C220J5C
A3C17	0180-0354			C: fxd Ta elect 40 μF ±5% 10 vdcw	56289	150D406X5010B2
A3C18	0180-0387			C: fxd Ta elect 47 μF ±5% 20 vdcw	56289	150D476X5020B2
A3C19	0140-0192		1	C: fxd mica 68 pF ± 5%	72136	obd
A3C20	0180-0387			C: fxd Ta elect 47 μF ±5% 20 vdcw	56289	150D476X5020B2
A3C21, A3C22	0180-0137			C: fxd Ta elect 100 μF ±20% 10 vdcw	56289	150D107X0010R2
A3CR1	1902-3104		1	Diode: Si breakdown 5.62 V ±5% 400 mW	04713	SZ10939-110
A3CR2	1902-3073		3	Diode: Si breakdown 4.32 V ±5%	04713	SZ10939-77
A3CR3	1901-0040		9	Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG 1088
A3CR4, A3CR5	1902-0048		11	Diode: breakdown 6.81 V ±5% 400 mW	04713	SZ10939-134
A3CR6				Not assigned		
A3CR7 thru A3CR9	1901-0040			Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG 1088
A3CR10	1902-0049		2	Diode: breakdown 6.19 V ±5% 400 mW	04713	SZ10939-122
A3CR11	1901-0040			Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG 1088
A3CR12				Not assigned		
A3CR13, A3CR14	1901-0040			Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263	FDG 1088
A3CR15	1902-3073			Diode: Si breakdown 4.32 V ±5%	04713	SZ10939-77
A3CR16	1901-0040			Diode: Si 30 wiv 30 mA 2 pF 2 ns	03877	SG 5050
A3CR17	1902-3073			Diode: Si breakdown 4.32 V ±5%	04713	SZ10939-77
A3CR18	1901-0040			Diode: Si 30 wiv 30 mA 2 pF 2 ns	03877	SG 5050

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3IC1, A3IC2	1820-0078		2	Integrated Circuit: JK flip flop	18324	obd
A3Q1, A3Q2	1854-0022			TSTR: **	-hp-	
A3Q3	1854-0094		7	TSTR: Si NPN 2N3646	07263	obd
A3Q4	1854-0221		3	TSTR: Si NPN dual	83740	BD-1148
A3Q5, A3Q6	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906-5
A3Q7, A3Q8	1854-0087		8	TSTR: Si NPN 2N3417	04713	MPS 3417
A3Q9 thru A3Q11	1854-0071		5	TSTR: Si NPN 2N3391	04713	MPS 3391
A3Q12	1854-0094			TSTR: Si NPN 2N3646	07263	obd
A3Q13, A3Q14	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906-5
A3Q15	1854-0094			TSTR: Si NPN 2N3646	07263	obd
A3Q16	1854-0022			TSTR: **	-hp-	
A3Q17	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906-5
A3Q18, A3Q19	1854-0094			TSTR: Si NPN 2N3646	07263	obd
A3Q20	1854-0215			TSTR: Si NPN 2N3904	04713	obd
A3Q21, A3Q22	1854-0022			TSTR: **	-hp-	
A3Q23	1854-0094			TSTR: Si NPN 2N3646	07263	obd
A3Q24, A3Q25	1854-0022			TSTR: **	-hp-	
A3Q26	1854-0094			TSTR: Si NPN 2N3646	07263	2N3646
A3R1	0683-5115			R: fxd comp 510 Ω ±5% 1/4 W	01121	CB 5115
A3R2	0683-2425		2	R: fxd comp 2400 Ω ±5% 1/4 W	01121	CB 2425
A3R3	0683-5135		4	R: fxd comp 51 kΩ ±5% 1/4 W	01121	CB 5135
A3R4	0698-3629		1	R: fxd met oxide ± 200 PPM/C 2 W	07115	LPI-3
A3R5	0683-2425			R: fxd comp 2400 Ω ±5% 1/4 W	01121	CB 2425
A3R6	0683-3925			R: fxd comp 3900 Ω ±5% 1/4 W	01121	CB 3925
A3R7, A3R8	0698-4435		8	R: fxd prec met flm 2490 Ω ±1% 1/8 W	75042	CEA T-0 obd
A3R9	0698-4391		2	R: fxd prec met flm 69.8Ω ±1% 1/8 W	75042	CEA T-0 obd
A3R10	0757-0469		6	R: fxd prec met flm 150 kΩ ±1% 1/8 W	75042	CEA T-0 obd
A3R11, A3R12	0698-4481		2	R: fxd prec met flm 16.5 kΩ ±1% 1/8 W	75042	CEA T-0 obd
A3R13	0757-0469			R: fxd prec met flm 150 kΩ ±1% 1/8 W	75042	CEA T-0 obd
A3R14	0698-4391			R: fxd prec met flm 69.8Ω ±1% 1/8 W	75042	CEA T-0 obd
A3R15	2100-1702		3	R: var ww 100 Ω ±10% 1 W	74868	2600 Series obd
A3R16	0757-0200		1	R: fxd prec met flm 5620Ω ±1% 1/8 W	19701	MF5C T-0 obd
A3R17	0683-1535			R: fxd comp 15 kΩ ±5% 1/4 W	01121	CB 1535
A3R18	0683-5105		1	R: fxd comp 51 Ω ±5% 1/4 W	01121	CB 5105
A3R19	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
A3R20				Not assigned		
A3R21	0683-3325		1	R: fxd comp 3300 Ω ±5% 1/4 W	01121	CB 3325
A3R22	0683-1525		3	R: fxd comp 1500 Ω ±5% 1/4 W	01121	CB 1525
A3R23	0683-3335		3	R: fxd comp 33 kΩ ±5% 1/4 W	01121	CB 3335
A3R24	0683-3025		1	R: fxd comp 3000 Ω ±5% 1/4 W	01121	CB 3025
A3R25	0683-3305		1	R: fxd comp 33 Ω ±5% 1/4 W	01121	CB 3305
A3R26	0683-5115			R: fxd comp 510 Ω ±5% 1/4 W	01121	CB 5115
A3R27	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
A3R28	0683-1535			R: fxd comp 15 kΩ ±5% 1/4 W	01121	CB 1535
A3R29	0683-6225		5	R: fxd comp 6200 Ω ±5% 1/4 W	01121	CB 6225
A3R30				Not assigned		
A3R31	0683-6225			R: fxd comp 6200 Ω ±5% 1/4 W	01121	CB 6225
A3R32	0698-4435			R: fxd prec met flm 2490 Ω ±1% 1/8 W	75042	CEA T-0 obd
A3R33	0757-0283		3	R: fxd prec met flm 2000 Ω ±1% 1/8 W	19701	MF7C T-0 obd
A3R34	0698-0082		2	R: fxd prec met flm 464 Ω ±1% 1/8 W	19701	MF5C T-0 obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3R35	0757-0453		2	R: fxd prec met flm 30.1 kΩ ±1% 1/8 W	19701	MF5C T-0 obd
A3R36	0812-0095		1	R: fxd ww 2 kΩ ± 3% 3 W	91637	RS2B-95 obd
A3R37	0683-2435		1	R: fxd comp 24 kΩ ±5% 1/4 W	01121	CB 2435
A3R38	0757-0453			R: fxd prec met flm 30.1 kΩ ±1% 1/8 W	75042	CEA T-0 obd
A3R39	0698-0082			R: fxd prec met flm 464 Ω ±1% 1/8 W	19701	MF5C T-0 obd
A3R40	0698-3630		1	R: fxd met oxide 300Ω ± 5% 2 W	75042	L42 obd
A3R41	0698-4435			R: fxd prec met flm 2490 Ω ±1% 1/8 W	75042	CEA T-0 obd
A3R42	0757-0283			R: fxd prec met flm 2000 Ω ±1% 1/8 W	19701	MF7C T-0 obd
A3R43	0683-5135			R: fxd comp 51 kΩ ±5% 1/4 W	01121	CB 5135
A3R44, A3R45	2100-1739		2	R: var ww 20 turn 5000 Ω ±10% 1 W	02660	2610 Series
A3R46*	0683-1535			R: fxd comp 15 kΩ ±5% 1/4 W	01121	CB 1535
A3R47	0683-1025		3	R: fxd comp 1000 Ω ±5% 1/4 W	01121	CB 1025
A3R48, A3R49	0683-3925			R: fxd comp 3900 Ω ±5% 1/4 W	01121	CB 3925
A3R50				Not assigned		
A3R51	0683-8225		1	R: fxd comp 8200 Ω ±5% 1/4 W	01121	CB 8225
A3R52	0757-0830		1	R: fxd comp 3920 Ω ±5% 1/2 W	01121	CB 3925
A3R53	0683-6225			R: fxd comp 6200 Ω ±5% 1/4 W	01121	CB 6225
A3R54	0683-1025			R: fxd comp 1000 Ω ±5% 1/4 W	01121	CB 1025
A3R55	2100-1435		1	R: var comp lin 3300 Ω ±10% 1/8 W	71450	QS 200
A3R56	0683-5115			R: fxd comp 510 Ω ±5% 1/4 W	01121	CB 5115
A3R57	0683-5135			R: fxd comp 51 kΩ ±5% 1/4 W	01121	CB 5135
A3R58, A3R59	0683-1045		2	R: fxd comp 100 kΩ ±5% 1/4 W	01121	CB 1045
A3R60	0683-5135			R: fxd comp 51 kΩ ±5% 1/4 W	01121	CB 5135
A3R61, A3R62	0683-3925			R: fxd comp 3900 Ω ±5% 1/4 W	01121	CB 3925
A3R63 thru A3R65	0698-4435			R: fxd prec met flm 2490 Ω ±1% 1/8 W	75042	CEA T-0 obd
A3R66	0683-1025			R: fxd comp 1000 Ω ±5% 1/4 W	01121	CB 1025
A3R67	0698-4435			R: fxd prec met flm 2490 Ω ±1% 1/8 W	75042	CEA T-0 obd
A4	03410-66504		1	Assembly: Power Supply and Meter Amplifier Board, includes: C1 thru C27 Q1 thru Q21 CR1 thru CR29 R1 thru R64 K1	-hp-	
A4C1	0150-0014		2	C: fxd cer 0.005 μF 500 vdcw	04222	D1-4 obd
A4C2	0180-0110		1	C: fxd Al elect 80 μF 75 vdcw	56289	Type 41D D33191
A4C3	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
A4C4	0180-0049		1	C: fxd Al elect 20 μF +75% -10% 50 vdcw	56289	30D206G050CC2-DSM
A4C5	0180-0050		3	C: fxd Al elect 40 μF +100% -15% 50 vdcw	56289	30D406G050DF6M1
A4C6	0150-0050			C: fxd cer 1000 pF 600 vdcw	84411	obd
A4C7	0180-0050			C: fxd Al elect 40 μF +100% -15% 50 vdcw	56289	150D406X5010B2
A4C8				Not assigned		
A4C9	0150-0014			C: fxd cer 0.005 μF 500 vdcw	04222	D1-4 obd
A4C10	0180-0149		1	C: fxd Al elect 65 μF +100% -10% 60 vdcw	56289	Type 30D D36978-DSM
A4C11	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
A4C12	0180-0045		2	C: fxd Al elect 20 μF +75% -10% 25 vdcw	56289	30D206G025CB2 DSM
A4C13	0180-0058		1	C: fxd Al elect 50 μF +75% -10% 25 vdcw	56289	30D506G025CC2-DSM
A4C14	0180-1719		1	C: fxd Ta elect 22 μF ±10% 25 vdcw	56289	109D226X9025C2
A4C15	0180-0374		1	C: fxd Ta elect 10 μF ± 10% 20 vdcw	56289	150D106X9020B2-DYS

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A4C16	0150-0050			C: fxd cer 1000 pF 600 vdcw	84411	obd
A4C17				Not assigned		
A4C18	0180-0059		1	C: fxd Al elect 10 μF +100% -10% 25 vdcw	56289	30D106G025BB2-DSM
A4C19, A4C20	0160-0128		2	C: fxd cer 2.2 μF ±20% 25 vdcw	56289	5C 15C2
A4C21	0180-0374		1	C: fxd Ta elect 10 μF ± 10% 20 vdcw	56289	150106X9020B2-DYS
A4C22	0180-0022		1	C: fxd Ta elect 3.9 μF ±10% 35 vdcw	56289	150D395X9035B2-DYS
A4C23	0140-0203		1	C: fxd mica 30 pF ±5%	04062	RDM15E300J5C
A4C24	0150-0050			C: fxd cer 1000 pF 600 vdcw	84411	obd
A4C25	0180-0050			C: fxd Al elect 40 μF +75% -10% 50 vdcw	56289	150D406X5010B2
A4C26	0150-0024		1	C: fxd cer 0.02 μF ±10% 600 vdcw	72982	841-000-Z5U-203Z
A4C27	0180-0045			C: fxd 20 μF +75% -10% 25 vdcw	56289	30D206G025CB2-DSM
A4CR1, A4CR2	1901-0158		6	Diode: Si 200 piv	04713	SR 1358-8
A4CR3 thru A4CR6	1901-0025			Diode: Si 100 wiv 12 pF 100 mA	07263	FD 2387
A4CR7	1902-0048			Diode: breakdown 6.81 V ±5% 400 mW	04713	SZ 10939-134
A4CR8	1901-0158			Diode: Si 200 piv	04713	SR 1358-8
A4CR9	1902-0048			Diode: breakdown 6.81 V ±5% 400 mW	04713	SZ 10939-134
A4CR10, A4CR11	1901-0025			Diode: Si 100 wiv 12 pF 100 mA	07263	FD 2387
A4CR12	1902-0048			Diode: breakdown 6.81 V ±5% 400 mW	04713	SZ 10939-134
A4CR13, A4CR14	1901-0158			Diode: Si 200 piv	04713	SR 1358-8
A4CR15 thru A4CR18	1901-0025			Diode: Si 100 wiv 12 pF 100 mA	07263	FD 2387
A4CR19	1902-0048			Diode: breakdown 6.81 V ±5% 400 mW	04713	SZ 10939-135
A4CR20	1901-0158			Diode: Si 200 piv	04713	SR 1358-8
A4CR21 thru A4CR23	1902-0048			Diode: breakdown 6.81 V ±5% 400 mW	04713	SZ 10939-135
A4CR24 thru A4CR26	1901-0025			Diode: Si 100 wiv 12 pF 100 mA	07263	FD 2387
A4CR27, A4CR28	1902-0048			Diode: breakdown 6.81 V ±5% 400 mW	04713	SZ 10939-135
A4CR29	1902-0049			Diode: breakdown 6.2 V 1N821 5.9 to 6.5 V 0.01%/^{o}C	04713	obd
A4K1	0490-0343			Relay Reed: sealed dry reed	-hp-	
A4Q1	1854-0022			TSTR: **	-hp-	
A4Q2	1854-0087			TSTR: Si NPN 2N3417	04713	MPS 3417
A4Q3	1854-0039			TSTR: Si NPN 2N3053	04713	2N3053
A4Q4	1854-0087			TSTR: Si NPN 2N3417	04713	MPS 3417
A4Q5	1853-0045		3	TSTR: Si PNP**	04713	obd
A4Q6 thru A4Q8	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906-5
A4Q9	1854-0221			TSTR: Si NPN Dual	83740	BD-1148
A4Q10	1854-0039			TSTR: Si NPN 2N3053	04713	2N3053
A4Q11, A4Q12	1854-0087			TSTR: Si NPN 2N3417	04713	MPS 3417
A4Q13	1853-0045			TSTR: Si PNP**	04713	obd
A4Q14	1854-0087			TSTR: Si NPN 2N3417	04713	MPS 3417
A4Q15, A4Q16	1854-0071			TSTR: Si NPN 2N3391	04713	MPS 3391
A4Q17, A4Q18	1853-0036			TSTR: Si PNP 2N3906	07263	2N3906-5
A4Q19	1854-0221			TSTR: Si NPN Dual	83740	BD-1148
A4Q20	1854-0087			TSTR: Si NPN 2N3417	04713	MPS 3417
A4Q21	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906-5

Table -1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A4R1	0683-2025			R: fxd comp 2000 Ω ±5% 1/4 W	01121	CB 2025	
A4R2	0683-1005		2	R: fxd comp 10 Ω ±5% 1/4 W	01121	CB 1005	
A4R3	0683-0275		1	R: fxd comp 2.7 Ω ±5% 1/4 W	01121	CB 27G5	
A4R4	0683-3925			R: fxd comp 3900 Ω ±5% 1/4 W	01121	CB 3925	
A4R5	0698-3161		1	R: fxd prec met flm 38.3 kΩ ±1% 1/8 W	19701	MF5C T-0	obd
A4R6	2100-1759		2	R: var ww lin 2000 Ω ±10% 1/2 W	75042	Type 506	obd
A4R7	0757-0439		2	R: fxd prec met flm 6810 Ω ±1% 1/8 W	19701	MF5C T-0	obd
A4R8				Not assigned			
A4R9	0683-5125			R: fxd comp 5100 Ω ±5% 1/4 W	01121	CB 5125	
A4R10	0683-0335		1	R: fxd comp 3.3 Ω ±5% 1/4 W	01121	CB 33G5	
A4R11	0757-0450			R: fxd 22.1 kΩ ±1% 1/8 W	07115	MF07CC4	
A4R12	0757-0440			R: fxd prec met flm 7500 Ω ±1% 1/8 W	19701	MF5C T-0	obd
A4R13	0683-2025			R: fxd comp 2000 Ω ±5% 1/4 W	01121	CB 2025	
A4R14	0683-1005			R: fxd comp 10 Ω ±5% 1/4 W	01121	CB 1005	
A4R15	0683-0755		1	R: fxd comp 7.5 Ω ±5% 1/4 W	01121	CB 75G5	
A4R16				Not assigned			
A4R17	0683-3925			R: fxd comp 3900 Ω ±5% 1/4 W	01121	CB 3925	
A4R18	0757-0447		1	R: fxd prec met flm 16.2 kΩ ±1% 1/8 W	75042	CEA T-0	obd
A4R19	2100-1759			R: var ww lin 2000 Ω ±10% 1/2 W	75042	Type 506	obd
A4R20	0757-0439			R: fxd prec met flm 6810 Ω ±1% 1/8 W	19701	MF5C T-0	obd
A4R21	0757-0469			R: fxd prec met flm 150 kΩ ±1% 1/8 W	75042	CEA T-0	obd
A4R22, A4R23	0757-0449		2	R: fxd prec met flm 20 kΩ ±1% 1/8 W	19701	MF5C T-0	obd
A4R24	0757-0469			R: fxd prec met flm 150 kΩ ±1% 1/8 W	75042	CEA T-0	obd
A4R25				Not assigned			
A4R26	2100-1702			R: var ww 100 Ω ±10% 1 W 20 turn	74868	2600 Series	
A4R27	0698-4477		1	R: fxd prec met flm 10.5 kΩ ±1% 1/8 W	75042	CEA T-0	obd
A4R28	0683-1525			R: fxd comp 1500 Ω ±5% 1/4 W	01121	CB 1525	
A4R29	0683-6225			R: fxd comp 6200 Ω ±5% 1/4 W	01121	CB 6225	
A4R30	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035	
A4R31	0757-0804		1	R: fxd prec met flm 200 Ω ±1% 1/2 W	19701	MF6C T-0	obd
A4R32	0683-3335			R: fxd comp 33 kΩ ±5% 1/4 W	01121	CB 3335	
A4R33	0683-8215		1	R: fxd comp 820 Ω ±5% 1/4 W	01121	CB 8215	
A4R34	0683-6225			R: fxd comp 6200 Ω ±5% 1/4 W	01121	CB 6225	
A4R35				Not assigned			
A4R36, A4R37	0683-2235			R: fxd comp 22 kΩ ±5% 1/4 W	01121	CB 2235	
A4R38	0683-3905			R: fxd comp 39 Ω ±5% 1/4 W	01121	CB 3905	
A4R39	0683-3625		1	R: fxd comp 3600 Ω ±5% 1/4 W	01121	CB 3625	
A4R40	0683-4725			R: fxd comp 4700 Ω ±5% 1/4 W	01121	CB 4725	
A4R41	0683-2215		1	R: fxd comp 220 Ω ±5% 1/4 W	01121	CB 2215	
A4R42	0683-5125			R: fxd comp 5100 Ω ±5% 1/4 W	01121	CB 5125	
A4R43	0683-6825		1	R: fxd comp 6800 Ω ±5% 1/4 W	01121	CB 6825	
A4R44	0683-1805		1	R: fxd 18 Ω ±5% 1/4 W	01121	CB 1805	
A4R45				Not assigned			
A4R46	0683-9135		1	R: fxd comp 91 kΩ ±5% 1/4 W	01121	CB 9135	
A4R47	0683-2745			R: fxd comp 270 kΩ ±5% 1/4 W	01121	CB 2745	
A4R48	0683-3005		1	R: fxd comp 30 Ω ±5% 1/4 W	01121	CB 3005	
A4R49	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035	
A4R50	0757-0469			R: fxd prec met flm 150 kΩ ±1% 1/8 W	75042	CEA T-0	obd
A4R51	0757-0401			R: fxd prec met flm 100 Ω ±1% 1/8 W	75042	CEA T-0	obd
A4R52	2100-1702			R: var ww 100 Ω ±10% 1 W	74868	2600 Series	
A4R53	0757-0290		1	R: fxd prec met flm 6190 Ω ±1% 1/8 W	75042	CEA T-0	obd
A4R54, A4R55	0757-0445		2	R: fxd 13 kΩ ±1% 1/8 W	19701	MF5C T-0	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A4R56	0757-0469			R: fxd prec met flm 150 kΩ ±1% 1/8 W	75042	CEA T-0 obd
A4R57	0757-0404		1	R: fxd prec met flm 130 Ω ±1% 1/8 W	19701	obd
A4R58	0683-1525			R: fxd comp 1500 Ω ±5% 1/4 W	01121	CB 1525
A4R59, A4R60	0698-3162		2	R: fxd prec met flm 46.4 kΩ ±1% 1/8 W	75042	CEA T-0 obd
A4R61	2100-1762		1	R: var ww lin 20 kΩ ±10% 1/2 W	75042	Type 506 obd
A4R62	0757-0283			R: fxd prec met flm 2 kΩ ±1% 1/8 W	19701	MF5C T-0 obd
A4R63	0757-0280		1	R: fxd prec met flm 2000 Ω ±1% 1/8 W	19701	MF5C T-0 obd
A4R64	0757-0411		1	R: fxd met flm 332 Ω ±1% 1/8 W	75042	CEA T-0 obd
A4R65	0683-1525		2	R: fxd comp 15 kΩ ± 5% 1/4 W	01121	CB 1525
C1, C2	0160-3333		2	C: fxd cer 5000 pF ±20% 250 vacw	08988	THD-8-502M-1.4 KV
DS1	1450-0106		1	Lamp: neon	87034	A1G obd
DS2	2140-0053		1	Lamp: incandescent 10 V 14 mA	24446	1869D obd
F1	2110-0008		1	Fuse: 0.5 amp 250 V	75915	312.500 obd
J1	1250-0083		1	Connector: series BNC bulkhead mount jack receptacle	95712	30624-1 obd
J2, J3	1250-0118		2	Connector: series BNC bulkhead mount jack receptacle	95712	30384-1 obd
J4	1251-0148		1	Connector: AC power 3 pin recessed power cord receptacle	82389	AC3G obd
J5	1251-0135		1	Connector: printed circuit 15 pin	02660	143-015-08 (1158)
J6, J7	1251-1263		2	Connector: printed circuit 30 pin	95354	FD6 30S-SF
M1	1120-0923		1	Meter: calibrated 100 μA	-hp-	
M1 (Opt. 01)	1120-0933		1	Meter: calibrated 100 μA	-hp-	
Q1	1854-0072		1	TSTR: Si NPN 2N3054	02735	2N3054
Q2	1853-0045			TSTR: Si PNP 2N4036	02735	2N4036
R1	2100-1917		1	R: var prec ww 10 kΩ ±5% 3 W	02660	Type 3461B
R2A, R2B	2100-1944		2	R: var comp 50 kΩ ±20% 1.12 W	01121	Type J obd
R3	2100-0261		1	R: var lin 2000 Ω ±20% 3/10 W	71450	obd
R4	0683-3335			R: fxd comp 33 kΩ ±5% 1/4 W	01121	CB 3335
R5	0757-0274		1	R: fxd comp 1210 Ω ±1% 1/8 W	75042	obd
S1	03410-61901		1	Switch Assembly Attenuator, includes: C1 R1 thru R13	-hp-	
S1C1	0140-0055		1	C: fxd mica 150 pF ±10%	72136	obd
S1R1	0757-0284		1	R: fxd prec met flm 150 Ω ±1% 1/8 W	75042	CEA T-0 obd
S1R2 thru S1R6	0698-3138		5	R: fxd prec met flm 277.5 Ω ±1/4% 1/4 W	19701	MF6C T-0 obd
S1R7 thru S1R12	0698-3139		6	R: fxd prec met flm 410.26 Ω ±1/4% 1/4 W	19701	MF6C T-0 obd
S1R13	0698-3137		1	R: fxd prec met flm 189.72 Ω ±1/4% 1/4 W	19701	MF6C T-0 obd
S2	03410-61902		1	Frequency Range Switch Assembly, includes: C1 thru C30	-hp-	
S2C1	0180-0100			C: fxd Ta elect 4.7 μF ±10% 35 vdcw	56289	150D475X9035B2-DYS
S2C2	0180-0376		1	C: fxd Ta elect 0.47 μF ±10% 35 vdcw	56289	150D474X9035A2-DYS
S2C3	0170-0040		1	C: fxd my 0.047 μF ±10% 200 vdcw	56289	192P47392-PTS
S2C4	0160-0161		2	C: fxd my 0.01 μF ±10%	56289	192P10392-PTS
S2C5	0160-0155		3	C: fxd my 0.0033 μF ±10% 200 vdcw	56289	192P33292-PTS
S2C6	0160-2376		1	C: fxd 0.1 μF ±5% 100 vdcw	01884	LP7A1B105J
S2C7	0160-0168		2	C: fxd my 0.1 μF ±10% 200 vdcw	56289	192P10492-PTS

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
S2C8	0160-0161			C: fxd my 0.01 μF ±10% 200 vdcw	56289	192P10392-PTS
S2C9	0160-0153		1	C: fxd my 0.001 μF ±10% 200 vdcw	56289	192P10292-PTS
S2C10	0160-0990		1	C: fxd mica 100 pF ±2%	04062	RDM15F101G3S
S2C11	0180-1799		1	C: fxd Ta elect 20 μF ±10% 35 vdcw	56289	150D206X9035R2-DYS
S2C12	0180-0100			C: fxd Ta elect 4.7 μF ±10% 35 vdcw	56289	150D475X9035B2-DYS
S2C13	0180-0291		1	C: fxd Ta elect 1.0 μF ±10% 35 vdcw	56289	150D105X9035A2-DYS
S2C14	0160-0889		2	C: fxd my 0.33 μF ±10% 80 vdcw	56289	192P3349R8-PTS
S2C15	0160-0163		2	C: fxd my 0.033 μF ±10% 200 vdcw	56289	192P33392-PTS
S2C16	0160-0155			C: fxd my 0.0033 μF ±10% 200 vdcw	56289	192P33292-PTS
S2C17	0180-0161		1	C: fxd Ta elect 3.3 μF ±20% 35 vdcw	56289	150D335X0035B2-DYS
S2C18	0160-0889			C: fxd my 0.33 μF ±10% 80 vdcw	56289	192P334948-PTS
S2C19	0160-0163			C: fxd my 0.033 μF ±10% 200 vdcw	56289	192P33392-PTS
S2C20	0160-0155			C: fxd my 0.0033 μF ±10% 200 vdcw	56289	192P33292-PTS
S2C21	0160-2012		1	C: fxd mica 330 pF ±5%	72136	obd
S2C22	0160-2375		2	C: fxd 0.47 μF ±2% 100 vdcw	01884	LP7A1B474G
S2C23	0160-2374		2	C: fxd 0.047 μF ±2% 100 vdcw	01884	LP7A1B473G
S2C24	0160-2373		2	C: fxd mica 4700 pF ±2% 300 vdcw	04062	RDM19F472G3S
S2C25	0160-2939		2	C: fxd mica 420 pF ±2% 500 vdcw	04062	RDM15F421G5S
S2C26	0160-2375			C: fxd 0.47 μF ±2% 100 vdcw	01884	LP7A1B474G
S2C27	0160-2374			C: fxd 0.047 μF ±2% 100 vdcw	01884	LP7A1B473G
S2C28	0160-2373			C: fxd mica 4700 pF ±2% 300 vdcw	04062	RDM19F472G3S
S2C29	0160-2939			C: fxd mica 420 pF ±2% 500 vdcw	04062	RDM15F421G5S
S2C30	0160-0168			C: fxd my 0.1 μF ±10% 200 vdcw	56289	192P10492-PTS
S3	3101-0038		1	Switch: toggle DPDT	04009	83054-H
S4	3101-0100		1	Switch: pushbutton AC power SPDT	87034	54-61681-26 A1H
S5	3101-0033		1	Switch: 115/230 V slide DPDT	82389	11A-1009
T1	9100-1357		1	Transformer: power	-hp-	
W1	8120-0078		1	Assembly: cable 7.5 ft. power cord set	70903	KH-4147
				MISCELLANEOUS		
	0400-0051		1	Grommet: polyethylene 3/8"	-hp-	
	03410-90000		1	Manual: operating and service	-hp-	
	0380-0059		4	Spacer: captive for No. 6 hardware	00866	obd
	1200-0080		4	Washer: insulator hard anodized aluminum 500 vdcw	76530	294834

SECTION VII
CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section contains circuit diagrams to aid in the operation and maintenance of the Model 3410A. Figure 7-1 is a functional circuit diagram which shows the overall relationship between the basic circuits of the instrument. Figures 7-2 through 7-6 contain the detailed schematic diagrams as well as component location drawings of each printed circuit board and the rotary switches.

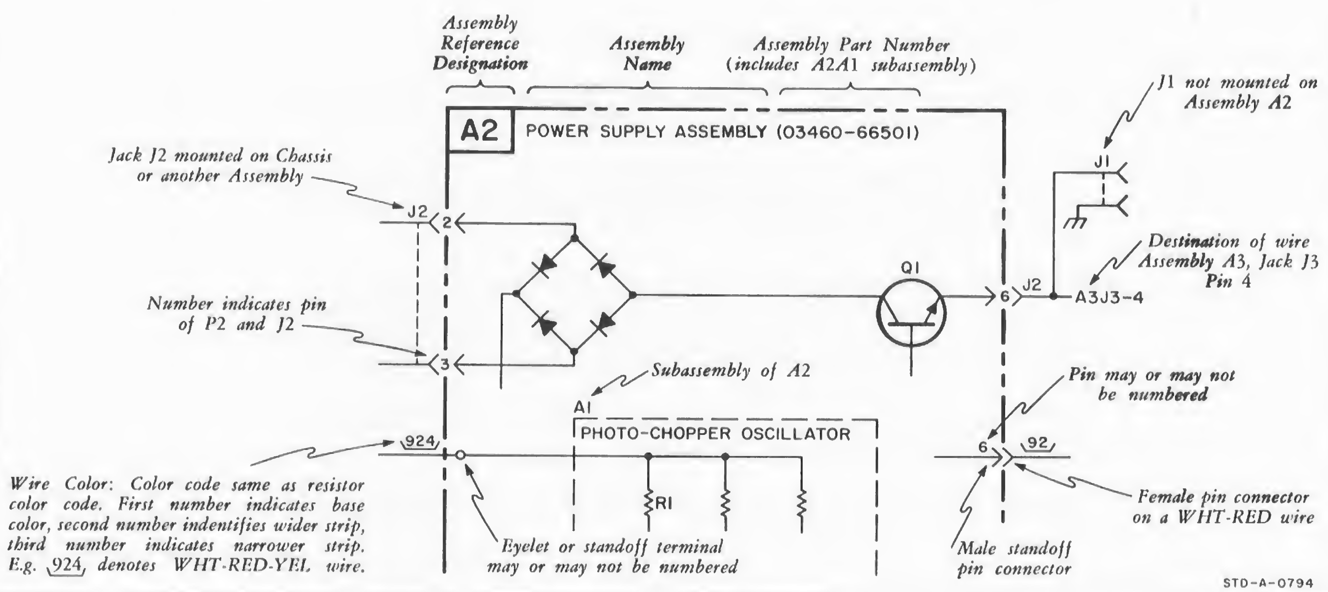
7-3. General schematic notes, which apply to all the schematic diagrams, are listed on Page 7-2.

7-4. An explanation of terms and symbols used on the schematic diagrams is given below.

REFERENCE DESIGNATIONS

PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

ASSEMBLY	SUBASSEMBLY	COMPONENT	COMPLETE DESIGNATION
A2	NONE	Q1	A2Q1
A2	A1	R1	A2A1R1
NONE	NONE	J1	J1

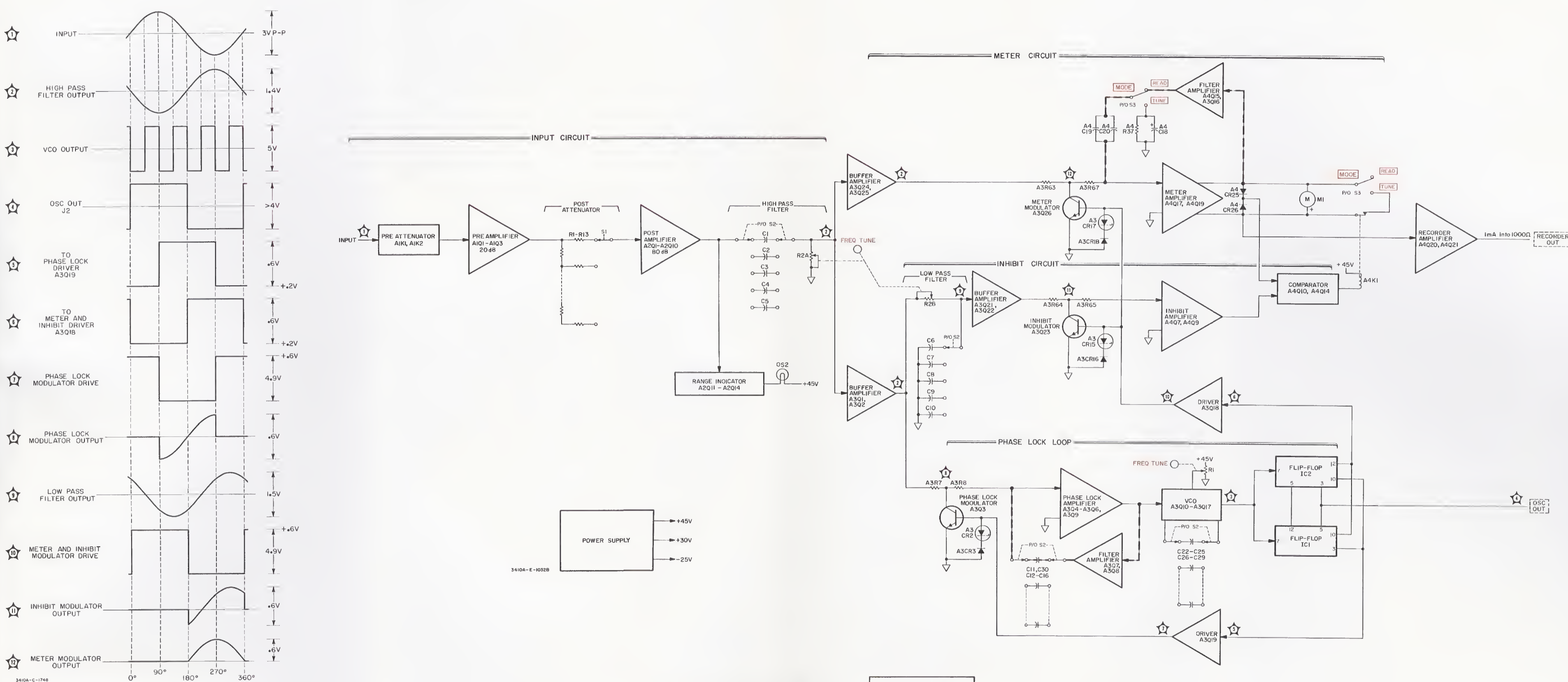


SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.

   RESISTANCE IN OHMS

   CAPACITANCE IN MICROFARADS
3. DENOTES CHASSIS GROUND.
4. DENOTES ASSEMBLY GROUND.
5. DENOTES ASSEMBLY.
6. DENOTES MAIN SIGNAL PATH.
7. DENOTES FEEDBACK PATH.
8. DENOTES FRONT PANEL MARKING.
9. DENOTES REAR PANEL MARKING.
10. DENOTES SCREWDRIVER ADJUST.
11. DENOTES FRONT PANEL CONTROL.
12. \924/ DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. (e. g. \924/ = WHITE, RED, YELLOW.)
13. TRANSISTORS ARE ALL CONNECTED TO CIRCUIT BOARD IN TO-5 CONFIGURATION, e. g. E C B AS VIEWED FROM THE COMPONENT SIDE OF BOARD.
14. VOLTAGE MEASUREMENTS WERE MADE WITH RESPECT TO CHASSIS GROUND USING A HIGH INPUT IMPEDANCE TRANSISTORIZED VOLTMETER. VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY SOMEWHAT FROM ONE INSTRUMENT TO ANOTHER.
15. DENOTES GROUND CONNECTION MADE WITH ASSEMBLY MOUNTING SCREWS IN PLACE.
16. DENOTES COMPONENTS NOT MOUNTED ON ASSEMBLY.



NOTE

WAVEFORMS TAKEN WITH FULL SCALE 1 KHZ INPUT SIGNAL.

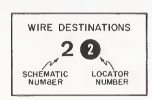
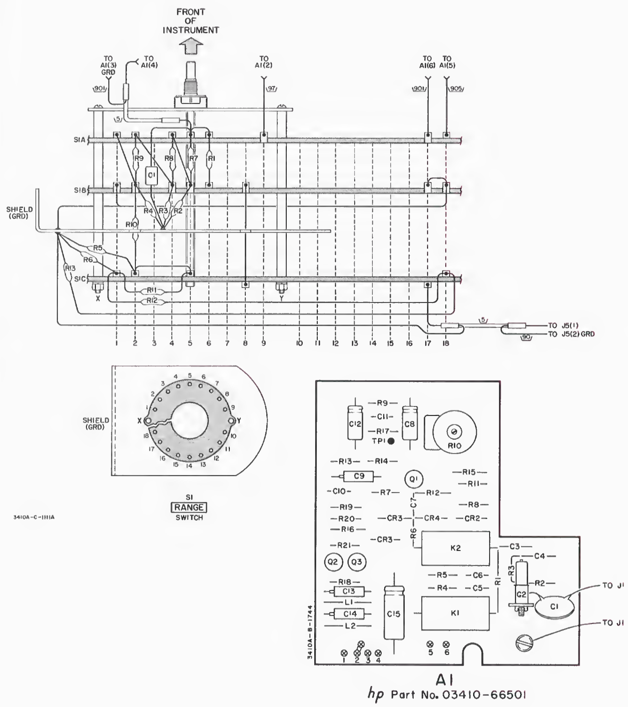
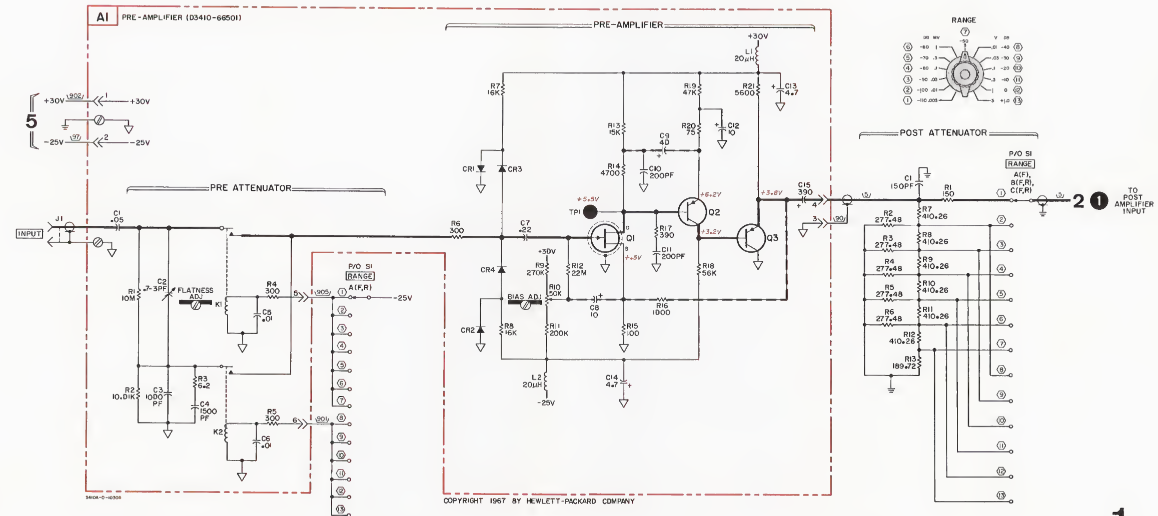


Figure 7-1. Functional Block Diagram

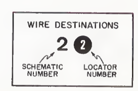
01825-1





NOTE

VOLTAGES SHOWN IN RED ARE DC VOLTAGES, WITH OR WITHOUT INPUT SIGNAL. WAVEFORMS ARE ON FIGURE 7-1.



01825-1

Figure 7-2. Preamplifier

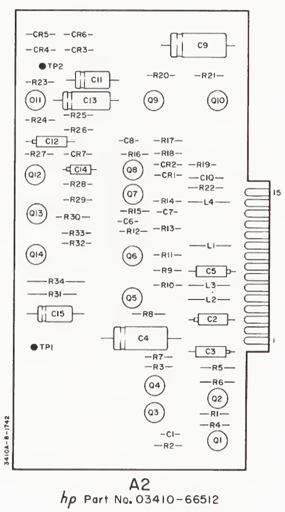
7-5. DETAILED TROUBLESHOOTING.

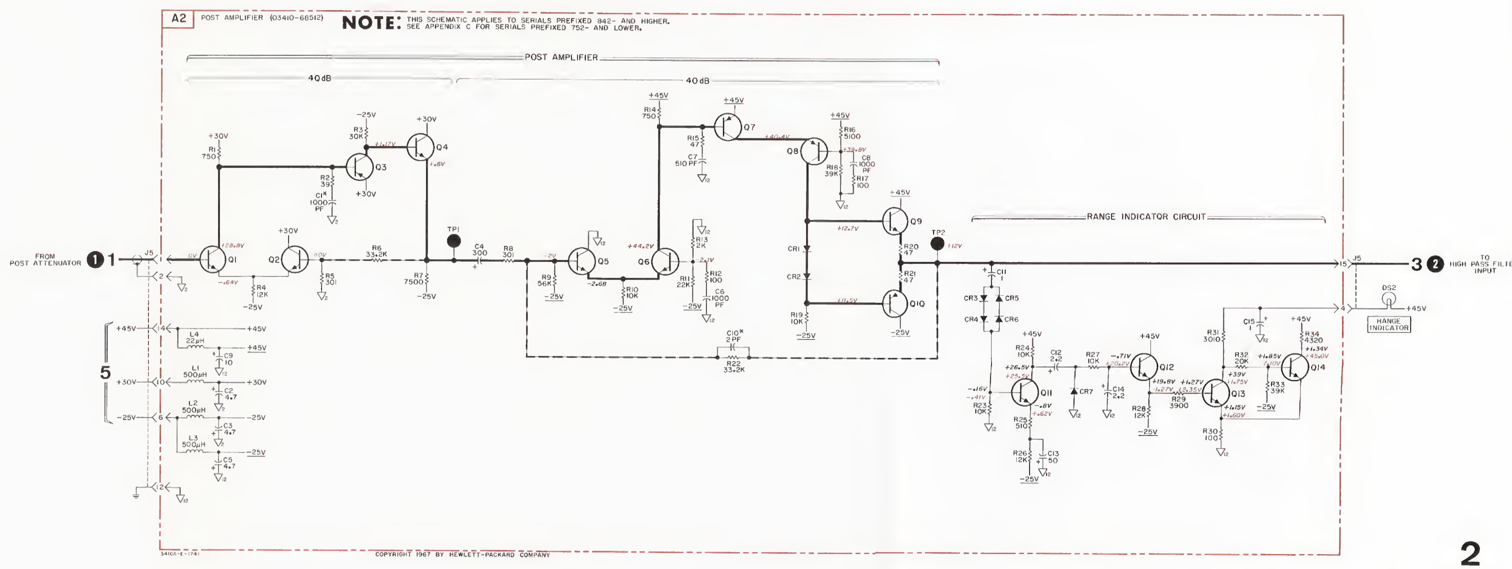
7-6. INPUT CIRCUIT TROUBLESHOOTING.

7-7. Using the Test Oscillator, apply a 3 V 400 Hz signal to the 3410A input. The RANGE INDICATOR should light on the .3V range and all ranges below it. If the RANGE INDICATOR lights only on the 3 mV range and lower, there is a problem in the pre-attenuator.

7-8. If the RANGE INDICATOR does not light at all, set the 3410A RANGE switch to .3V. The signal at A2TP1 should be about 0.1V p-p. If this signal is present, go to the next paragraph. If not, measure the dc voltages around A2Q1 through A2Q4. Refer to Figure 7-3 for typical voltage levels. If these voltages are normal, troubleshoot the A1 pc board assembly located just behind the input jack. Four screws hold the shield in place over the A1 assembly. Refer to Figure 7-2 for typical voltage levels.

7-9. If the 1V p-p signal was present at A2TP1, apply a 3V input signal with the 3410A RANGE set to 3V. A signal of approximately 1V p-p should be present at A2TP2. If not, measure the dc voltages around A2Q5 through A2Q10. Refer to Figure 7-3 for typical voltage levels.





2

NOTE

VOLTAGES SHOWN ARE DC. RED INDICATES NO INPUT SIGNAL, BLACK INDICATES FULL SCALE 1 KHZ INPUT SIGNAL. WAVEFORMS ARE ON FIGURE 7-1.

WIRE DESTINATIONS
2 ❷
SCHEMATIC NUMBER — LOCATOR NUMBER

01825-1

Figure 7-3. Post Amplifier

7-10. PHASE LOCK LOOP TROUBLESHOOTING.

7-11. If there is a square wave output at the tuned frequency present at the OSC. OUT connector on the 3410A rear panel, go to Paragraph 7-13. If not, continue with the following steps to check out the flip-flops.

a. Check pin 7 of each flip-flop for a 5V p-p square wave at four times the tuned frequency. If the square wave is present, go to step b. If not, check the VCO as in 7-12.

b. Check pin 3 of IC1 and pin 12 of IC2 for a 5 V peak to peak square wave at the tuned frequency. If the square wave is present, the flip-flops are operating normally. Go to 7-13. If the square wave is not present, go to step c.

c. Check pin 8 of both flip-flops for approximately +5.6 V dc. If +5.6 V dc is present, go to step e. If not, go to step d.

d. Lift the anode end of A3CR1 and measure the resistance from A3TP3 to ground. If approximately 2 kΩ is measured, check the +5.6V power supply, A3CR1. If some other resistance is found, go to step e. Reconnect A3CR1.

e. Connect a dc voltmeter (-hp- Model 427A) to pin 3 of IC1, which should read either +5 V dc or 0 V dc, depending on which state the flip-flop is in.

f. Using a clip lead, make alternate momentary contact from IC1 pin 7 to pin 8, and from IC1 pin 7 to ground. If IC1 changes state, it is good.

g. Connect the dc voltmeter to pin 12 of IC2 and repeat step g.

h. Connect the dc voltmeter to pin 12 of IC2 and repeat step g.

7-12. To troubleshoot the Voltage Controlled Oscillator, use the following procedure:

a. Observe the waveform 3 at the collector of A3Q15. If a 5V p-p square wave is present at four times the tuned frequency, the VCO is operating normally. Go to Paragraph 7-13.

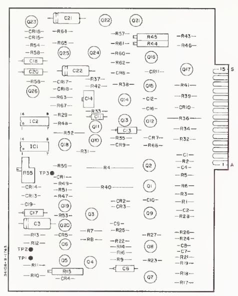
b. If there is no square wave present, check dc voltage levels on the transistors. Refer to Figure 7-4 for typical voltages.

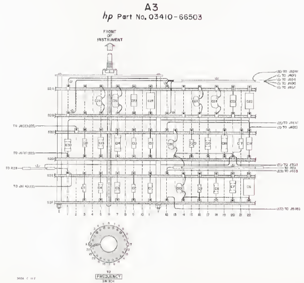
7-13. To troubleshoot the Phase Lock Amplifier, use the following procedure:

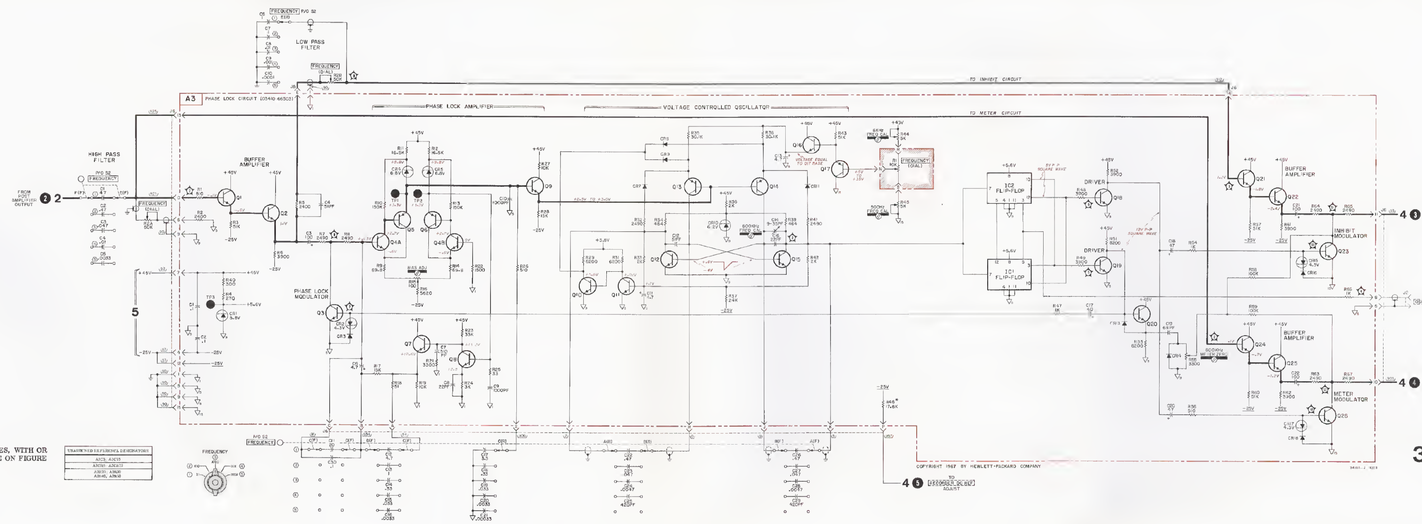
a. Observe the waveform 7 at the base of A3 Q3. A 4.9V square wave should be present.

b. Observe the waveform 2 at pin D of the pc assembly connector. A 1.4V p-p sine wave should be present.

c. Observe the waveform 8 at the collector of A3Q3. Refer to Figure 7-1 for the proper waveform. If no signal is present, check A3Q1 and A3Q2. If an unsynchronized signal is present, check dc voltage levels around A3Q4 through A3Q8.







NOTE

VOLTAGES SHOWN IN RED ARE DC VOLTAGES, WITH OR WITHOUT INPUT SIGNAL. WAVEFORMS ARE ON FIGURE 7-1.

WIRE DESTINATIONS 2 ❷ SCHEMATIC NUMBER LOCATOR NUMBER

Figure 7-4. Phase Lock Circuit

7-14. INHIBIT CIRCUIT TROUBLESHOOTING.

7-15. With no input signal and FREQUENCY set to the X100 range, the voltage at A4TP4 should be .8V less than that at A4TP5. If not, check transistors A4Q10, 11, and 13. Refer to Figure 7-5 for typical voltages. A4Q7, 8 and 9 may be checked using the general procedure for checking differential amplifiers as follows:

a. Remove the output load from the differential amplifier (lift the base of A4Q10).

b. Vary the Amplifier Bal Adj A4R26 while measuring the voltage at the emitters of A4Q7 and 8. If both voltages vary, the differential amplifier is operating.

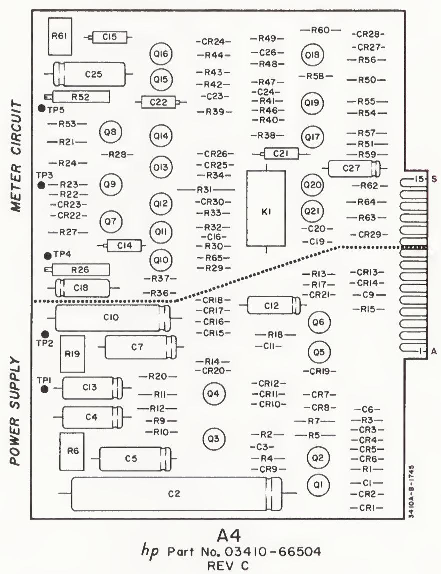
7-16. METER CIRCUIT TROUBLESHOOTING.

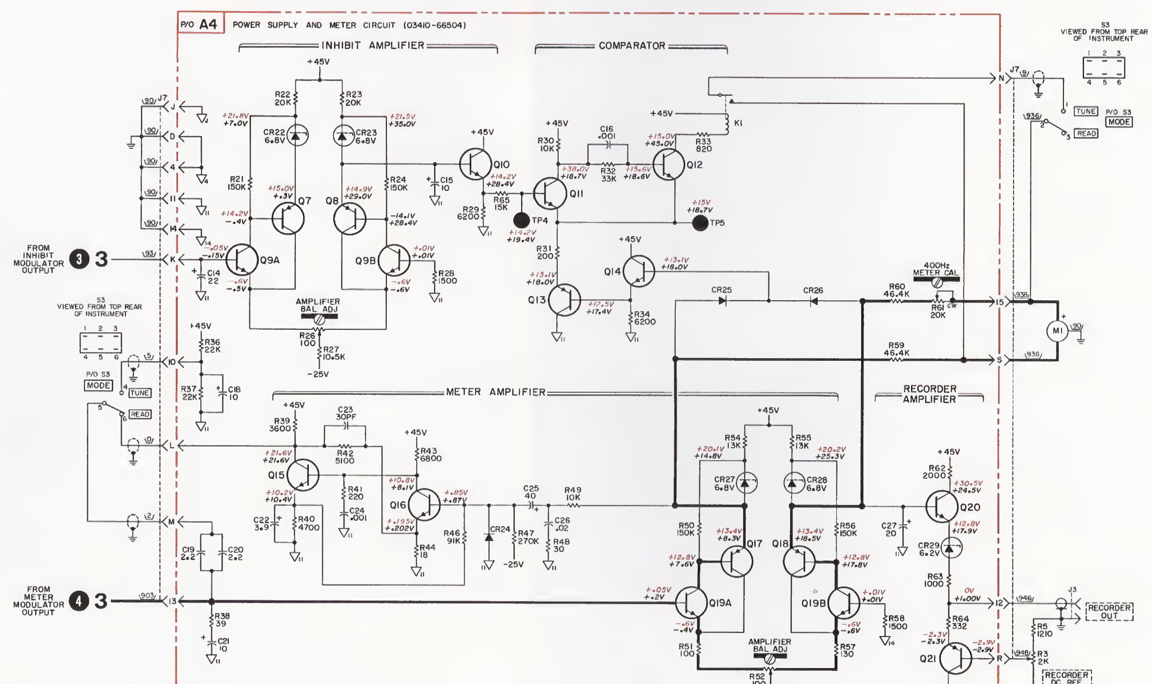
7-17. Apply a full scale sine wave input signal to the 3410A, which should be tuned to the input frequency. Use an oscilloscope and a 10:1 probe to observe the waveform at the collector of A3Q26. The positive half of a sine wave, .6V in amplitude, should be observed. (See 12 on Figure 7-1).

7-18. Check the differential amplifier as follows:

a. Remove the output load from the differential amplifier (lift the base of A4Q20).

b. Vary the Amplifier Bal Adj A4R52 while measuring the voltage at the emitters of A4Q17 and 18. If both voltages vary, the amplifier is operating.





UNASSIGNED REFERENCE DESIGNATORS
A4C17
A4R25, A4R35, A4R45

4

NOTE

VOLTAGES SHOWN ARE DC. RED INDICATES NO INPUT SIGNAL, BLACK INDICATES FULL SCALE 1 KHZ INPUT SIGNAL. WAVEFORMS ARE ON FIGURE 7-1.

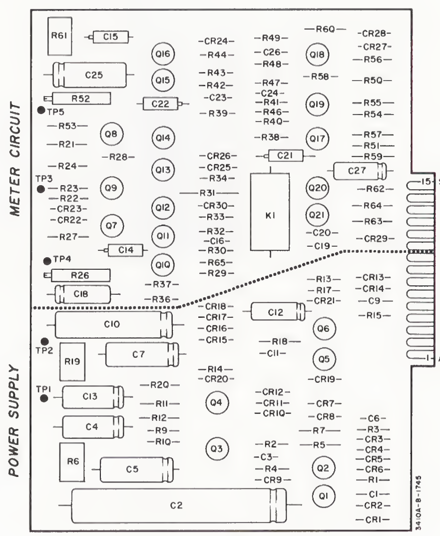
WIRE DESTINATIONS

2 ❷

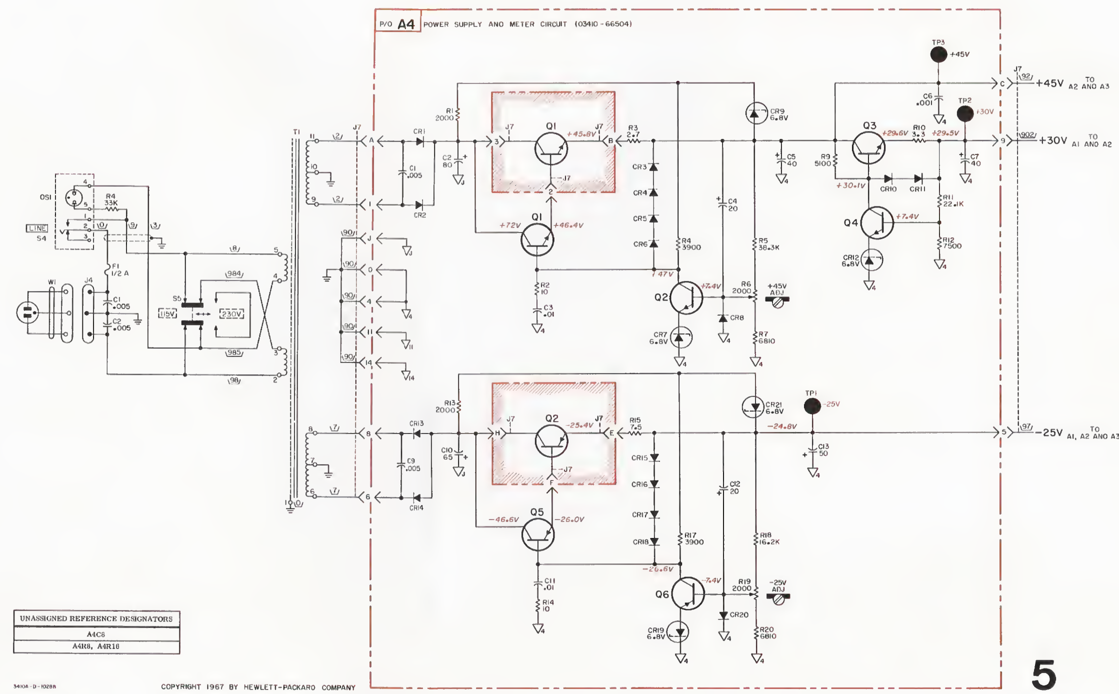
SCHEMATIC NUMBER LOCATOR NUMBER

01825-1

Figure 7-5. Meter Circuit



A4
hp Part No. 03410-66504
REV C



UNASSIGNED REFERENCE DESIGNATORS
A4C6
A4R8, A4R16

3410A-D-10288

NOTE

VOLTAGES SHOWN IN RED ARE DC. ADJUST +45 V FOR +45.0 V AT TP3. ADJUST -25 V TO -24.8 V AT TP1. TP2 SHOULD READ BETWEEN +28.5 V AND +29.8 V.

01825-1

Figure 7-6. Power Supply

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U. S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N. Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N. Y.
00373	Garlock Inc.	Cherry Hill, N. J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N. J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N. J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01670	Gudebrod Bros. Silk Co.	New York, N. Y.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.
02116	Wheelock Signals, Inc.	Long Branch, N. J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N. J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
02875	Hudson Tool & Die	Newark, N. J.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N. J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N. J.
04062	Arco Electronic Inc.	Great Neck, N. Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04673	Dakota Engr. Inc.	Culver City, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Elect. Div.	New York, N. Y.
05574	Viking Ind. Inc.	Canoga Park, Calif.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N. Y.
05729	Metro-Tel Corp.	Westbury, N. Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N. Y.
06402	E. T. A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N. Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N. H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N. Y.
07149	Filmohm Corp.	New York, N. Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07256	Silicon Transistor Corp.	Carle Place, N. Y.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N. J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N. J.
08145	U. S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N. J.
08792	CBS Electronics Semiconductor Operations, Div of C. B. S. Inc.	Lowell, Mass.
08806	General Electric Co. Miniat. Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N. Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11453	Precision Connector Corp.	Jamaica, N. Y.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N. J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N. J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N. M.
12697	Clarostat Mfg. Co.	Dover, N. H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N. J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N. J.
14674	Corning Glass Works	Corning, N. Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N. Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N. Y.
15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N. J.
16585	Boots Aircraft Nut Corp.	Pasadena, Calif.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N. Y.
16758	Delco Radio Div. of G. M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
17870	McGraw-Edison Co.	Manchester, N. H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.

CODE LIST OF MANUFACTURERS (Cont'd)

Code No.	Manufacturer	Address
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Calif.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.

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CODE LIST OF MANUFACTURERS (Cont'd)

Code No.	Manufacturer	Address
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . . . .
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Calif.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Wesbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Calif.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96306	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
96881	Thomson Ind. Inc.	Long Is., N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Troncis, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

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SUPPLEMENTAL CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
01884	Dearborn Electronic Laboratories, Inc.	Chicago, Ill.
07115	Corning Glass Works	Bradford, Pa.
08988	Skottie Electronics Inc.	Peckville, Penn.
24446	General Electric Co.	Schenectady, N. Y.

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TWX: 910-952-1162

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TWX: 910-373-1280

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7965 East Prentice
Englewood 80110
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Norwalk 06851
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621 Commonwealth Avenue
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Tel: (305) 841-3970
TWX: 810-850-0113

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410 150th Avenue
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Tel: (813) 391-0211
TWX: 810-863-0366

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450 Interstate North
Atlanta 30328
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4002 Meadows Drive
Indianapolis 46205
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TWX: 810-341-3263

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TWX: 810-955-5524

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6707 Whitestone Road
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Tel: (301) 944-5400
TWX: 710-862-0850

P.O. Box 1648
2 Choke Cherry Road
Rockville 20850
Tel: (301) 948-6370
TWX: 710-828-9684

MASSACHUSETTS
32 Hartwell Ave.
Lexington 02173
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TWX: 710-326-6904

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24315 Northwestern Highway
Southfield 48075
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TWX: 810-232-1532

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MISSOURI
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Kansas City 64114
Tel: (816) 333-2445
TWX: 910-771-2087

2812 South Brentwood Blvd.
St. Louis 63144
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TWX: 910-760-1670

NEW JERSEY
W. 120 Century Road
Paramus 07652
Tel: (201) 265-5000
TWX: 710-990-4951

1060 N. Kings Highway
Cherry Hill 08034
Tel: (609) 667-4000
TWX: 710-892-4945

NEW MEXICO
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Station C
6501 Lomas Boulevard N.E.
Albuquerque 87108
Tel: (505) 255-5586
TWX: 910-989-1665

156 Wyatt Drive
Las Cruces 88001
Tel: (505) 526-2485
TWX: 910-983-0550

NEW YORK
1702 Central Avenue
Albany 12205
Tel: (518) 869-8462
TWX: 710-441-8270

1219 Campville Road
Endicott 13764
Tel: (607) 754-0050
TWX: 510-252-0890

82 Washington Street
Poughkeepsie 12601
Tel: (914) 454-7330
TWX: 510-248-0012

39 Saginaw Drive
Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981

1025 Northern Boulevard
Roslyn, Long Island 11576
Tel: (516) 869-8400
TWX: 510-223-0811

5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
TWX: 710-541-0482

NORTH CAROLINA
P.O. Box 5188
1923 North Main Street
High Point 27262
Tel: (919) 882-6873
TWX: 510-926-1516

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25575 Center Ridge Road
Cleveland 44145
Tel: (216) 835-0300
TWX: 810-421-8500

3460 South Dixie Drive
Dayton 45439
Tel: (513) 298-0351
TWX: 810-459-1925

OKLAHOMA
2919 United Founders Boulevard
Oklahoma City 73112
Tel: (405) 848-2801
TWX: 910-830-6862

OREGON
Westhills Mall, Suite 158
4475 S.W. Scholls Ferry Road
Portland 97225
Tel: (503) 292-9171
TWX: 910-464-6103

PENNSYLVANIA
2500 Moss Side Boulevard
Monroeville 15146
Tel: (412) 271-0724
TWX: 710-797-3650

8th Avenue
King of Prussia Industrial Park
King of Prussia 19406
Tel: (215) 265-7000
TWX: 510-660-2670

TEXAS
P.O. Box 1270
201 E. Arapahoe Rd.
Richardson 75080
Tel: (214) 231-6101
TWX: 910-867-4723

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4242 Richmond Avenue
Houston 77027
Tel: (713) 667-2407
TWX: 910-881-2645

GOVERNMENT CONTRACT OFFICE
225 Billy Mitchell Road
San Antonio 78226
Tel: (512) 434-4171
TWX: 910-871-1170

UTAH
2890 South Main Street
Salt Lake City 84115
Tel: (801) 486-8166
TWX: 910-925-5681

VIRGINIA
P.O. Box 6514
2111 Spencer Road
Richmond 23230
Tel: (703) 282-5451
TWX: 710-956-0157

WASHINGTON
433-108th N.E.
Bellevue 98004
Tel: (206) 454-3971
TWX: 910-443-2303

FOR U.S. AREAS NOT LISTED:
Contact the regional office nearest you: Atlanta, Georgia . . . North Hollywood, California . . . Paramus, New Jersey . . . Skokie, Illinois. Their complete addresses are listed above.

CANADA

ALBERTA
Hewlett-Packard (Canada) Ltd.
11745 Jasper Ave.
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Tel: (403) 482-5561
TWX: 610-831-2431

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Hewlett-Packard (Canada) Ltd.
304-1037 West Broadway
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Tel: (604) 738-5301
TWX: 610-922-5059

MANITOBA
Hewlett-Packard (Canada) Ltd.
511 Bradford Ct.
St. James
Tel: (204) 786-7581

NOVA SCOTIA
Hewlett-Packard (Canada) Ltd.
7001 Mumford Road
Suite 356
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Tel: (902) 455-0511
TWX: 610-271-4482

ONTARIO
Hewlett-Packard (Canada) Ltd.
880 Lady Ellen Place
Ottawa 3
Tel: (613) 722-4223
TWX: 610-562-1952

Hewlett-Packard (Canada) Ltd.
1415 Lawrence Avenue West
Toronto
Tel: (416) 249-9196
TWX: 610-492-2382

QUEBEC
Hewlett-Packard (Canada) Ltd.
275 Hymus Boulevard
Pointe Claire
Tel: (514) 697-4232
TWX: 610-422-3022
Telex: 01-20607

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Lavalle 1171 - 3°
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Hewlett-Packard Do Brasil
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Rua Coronel: Oscar Porto, 691
Sao Paulo - 8, SP
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Hewlett-Packard Do Brasil
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Rio de Janeiro, ZC-39, GB
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Cable: HEWPACK Rio de Janeiro

CHILE
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Estado 215 - Oficina 1016
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Instrumentacion
Henrik A. Langebaek & Kier Ltda.
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Cable: AARIS Bogota

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Tel: 12496
Cable: HORVATH Quito

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Apartado Postal 1589
27 Avenida Norte 1133
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Cable: ELECTRONICA San Salvador

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Cable: OLALA Guatemala City

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Tel: 30833
Cable: ELECTRON Panama City

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Cable: FEPERU Lima

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San Juan Electronics, Inc.
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Ponce de Leon 154
Pda. 3-Pta. de Tierra
San Juan, P.R. 00906
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Cable: SATRONICS San Juan
Telex: SATRON 3450 332

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Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
Tel: 40-3102
Cable: RADIUM Montevideo

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Hewlett-Packard De Venezuela C.A.
Apartado del Este 10934
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Tel: 71.88.05
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Cable: PALOBEN Brussels
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Cable: HEWPACK AS
Telex: 66 40

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Helsinki 20
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Cable: HEWPACKOY-Helsinki
Telex: 12-1563

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Boite Postale No. 6
91 Orsay
Tel: 920 88 01
Cable: HEWPACK Paris
Telex: 60048 HEWPACK ORSAY

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69 **Lyon** 5e
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E 1/69

MANUAL BACKDATING CHANGES

MODEL 3410A

AC MICROVOLTMETER

Manual Serials Prefixed: 842-
-hp- Part No. 03410-90002

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
648-00124 and below*	1, 2, 3, 4, 5		
728-, 719-, 648	2, 3, 4, 5		
731-	3, 4, 5		
735-, 752	4, 5		

*Except the following serial numbers:
648-00102
648-00104
648-00107
648-00113
648-00116 - 00119
648-00121 - 00123

CHANGE #1

Figure 7-5
Delete R5, and put straight wire in its place.
Change A4R62 to 4.3 kΩ.
Change A4R63 to 2 kΩ.
Change A4R64 to 1 kΩ.

Table 6-1
Delete R5.
Change A4R62 to 0683-4325, 4.3 kΩ ± 1% 1/4 W.
Change A4R63 to 0757-0283, 2 kΩ ± 1% 1/8 W.
Change A4R64 to 0757-0280, 1 kΩ ± 1% 1/8 W.

CHANGE #2

Figure 7-4
Change A3R9 and A3R14 to 100Ω.
Change A3R11 and A3R12 to 22.1 kΩ.
Change A3R16 to 7500Ω.

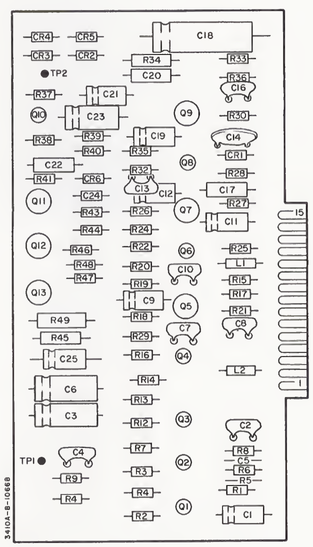
Table 6-1
Change A3R9 and A3R14 to 0757-0401, 100Ω ± 1% 1/8 W.
Change A3R11 and A3R12 to 0757-0450, 22.1 kΩ ± 1% 1/8 W.
Change A3R16 to 0757-0440, 7500Ω ± 1% met flm 1/8 W.

NOTE

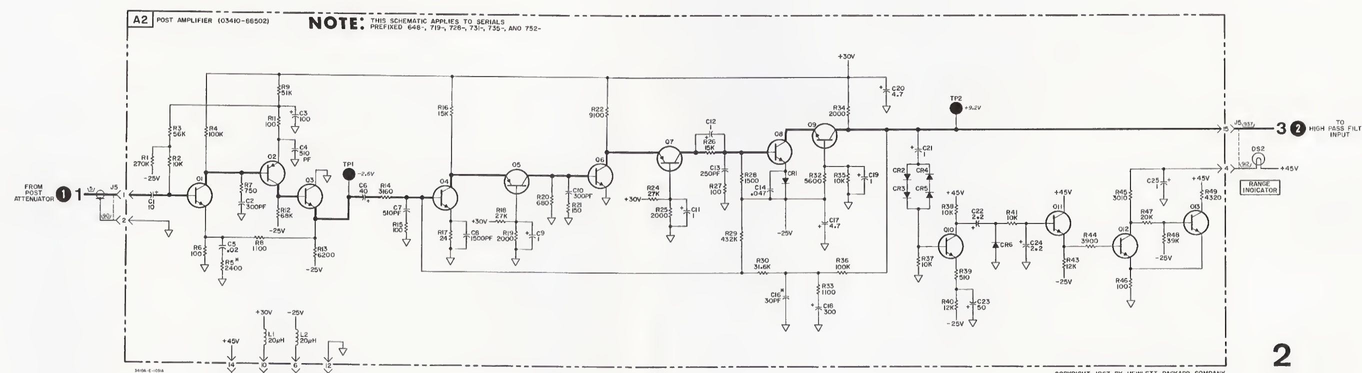
If any of the resistors are changed to the values shown in the manual, all five must be changed together.

CHANGE #3

Figure 7-4
Change the series combination of A3R4 and A3R40 to a single resistor A3R4, 0766-0013, 563Ω 3 W.



A2
(*hp* Part No. 03410-66502)



UNASSIGNED REFERENCE DESIGNATORS
A2C15
A2R10, A2R23 A2R31, A2R42

Manual Backdating Changes Model 3410A Page 3

CHANGE #4

Figure 7-4
Change A3CR2, A3CR15, A3CR17 to 4.32 V.

Table 6-1
Change A3CR2, A3CR15, A3CR17 to 1902-3073, 4.32 V.
Change A3Q3, A3Q18, A3Q19, A3Q23, A3Q26 to 1854-0094, 2N3646.

NOTE

If any of these eight components are changed to values listed in the manual, all eight must be changed together.

CHANGE #5

Figure 7-3, Page 7-7/7-8
This schematic diagram is not applicable. Use the backdating schematic.

Table 6-1
The A2 Assembly list is not applicable. Use the following Replaceable Parts List.

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2	03410-66502	1	Assembly: Amplifier Board	-hp-	
A2C1	0180-0224		C: fxd Al elect 10 μF +75% -10% 15 vdcw	56289	30D106G015BA4
A2C2	0160-2207	2	C: fxd mica 300 pF ±5%	04062	RDM15F301J3C
A2C3	0180-0061	2	C: fxd Al elect 100 μF +75% -10% 15 vdcw	56289	30D107G015DC2-DSM
A2C4	0160-0362	2	C: fxd mica 510 pF ±5%	04062	RDM15F511J3C
A2C5			Not assigned		
A2C6	0180-0050	1	C: fxd Al elect 40 μF +75% -10% 50 vdcw	56289	30D406G050DD2-DS
A2C7	0160-0362		C: fxd mica 510 pF ±5%	04062	RDM15F511J3C
A2C8	0140-0156	1	C: fxd mica 1500 pF ±2%	04062	RDM19F152G3C
A2C9	0180-0119	5	C: fxd Al elect 1.0 μF +75% -10% 25 vdcw	56289	5C13C obd
A2C10	0160-2207		C: fxd mica 300 pF ±5%	04062	RDM15F301J3C
A2C11, A2C12	0180-0119		C: fxd Al elect 1.0 μF ±20% 25 vdcw	56289	5C13C obd
A2C13	0160-2018	1	C: fxd mica 250 pF ±5% 500 vdcw	04062	RDM15F251J5S
A2C14	0150-0052	1	C: fxd cer 0.05 μF ±20% 400 vdcw	56289	33C17A
A2C15			Not assigned		
A2C16	0140-0203	1	C: fxd mica 30 pF ±5%	04062	RDM15E300J5C
A2C17	0180-0100	2	C: fxd Ta elect 4.7 μF ±10% 35 vdcw	56289	150D475X9035B2
A2C18	0180-0062		C: fxd Al elect 300 μF +75% -10% 6 vdcw	56289	30D307G006DF2-DSM
A2C19	0180-0119		C: fxd Al elect 1.0 μF ±20% 25 vdcw	56289	5C13C
A2C20	0180-0100		C: fxd Ta elect 4.7 μF ±10% 35 vdcw	56289	150D475X9035B2
A2C21	0180-0119		C: fxd Al elect 1.0 μF ±20% 25 vdcw	56289	5C13C
A2C22	0180-1846	1	C: fxd Ta elect 2.2 μF ±10% 35 vdcw	56289	150D225X9035B2-DYS
A2C23	0180-0033	1	C: fxd Al elect 50 μF +100% -10% 6 vdcw	56289	30D506G006CB2-DSM
A2C24	0180-0155	1	C: fxd Ta elect 2.2 μF ±20% 20 vdcw	56289	150D225X0020A2-DYS
A2C25	0180-0269		C: fxd Al elect 1 μF +75% -10% 50 vdcw	56289	30D105G150BA2-DSM
A2CR1 thru A2CR6	1901-0025	6	Diode: Si 100 wiv 12 pF 100 mA	07263	FD 2387

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2L1, A2L2	9140-0047	1	Coil: RF 20 μH 2.6Ω 1/4"	99848	3100-15-101
A2Q1	1854-0215	4	TSTR: Si NPN 2N3904	04713	obd
A2Q2	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-5
A2Q3, A2Q4	1854-0215		TSTR: Si NPN 2N3904	04713	obd
A2Q5	1853-0016	2	TSTR: Si PNP 2N3638	07263	2N3638
A2Q6	1854-0071	6	TSTR: Si NPN 2N3391	04713	MPS 3391
A2Q7	1853-0016		TSTR: Si PNP 2N3638	07263	2N3638
A2Q8	1854-0071		TSTR: Si NPN 2N3391	04713	MPS 3391
A2Q9	1854-0039	2	TSTR: Si NPN 2N3053	04713	2N3053 obd
A2Q10	1854-0215		TSTR: Si NPN 2N3904	04713	obd
A2Q11 thru A2Q13	1854-0022	11	TSTR: 2N2102	07263	S17843
A2R1	0683-2745	1	R: fxd prec met flm 270K ±1% 1/4 W	19701	MF5C T-O obd
A2R2	0683-1035	5	R: fxd comp 10 KΩ ±5% 1/4 W	01121	CB 1035
A2R3	0683-5635	1	R: fxd comp 56 KΩ ±5% 1/4 W	01121	CB 5635
A2R4	0683-1045		R: fxd comp 100 KΩ ±5% 1/4 W	01121	CB 2745
A2R5			Not assigned		
A2R6	0698-5438	1	R: fxd prec met flm 100Ω ±1/4% 1/8 W	75042	CEA T-2 obd
A2R7	0683-7515	1	R: fxd comp 750Ω ±5% 1/4 W	01121	CB 7515
A2R8	0698-5444	2	R: fxd prec met flm 1100Ω ±1/4% 1/8 W	75042	CEA T-2 obd
A2R9	0683-5135	1	R: fxd comp 51K ±5% 1/4 W	01121	CB 3035
A2R10			Not assigned		
A2R11	0683-1015	3	R: fxd comp 100Ω ±5% 1/4 W	01121	CB 1015
A2R12	0683-6835	5	R: fxd comp 68K ±5% 1/4 W	01121	CB 1525
A2R13	0683-6225	1	R: fxd comp 6200Ω ±5% 1/4 W	01121	CB 6225
A2R14	0698-5440	1	R: fxd prec met flm 3160Ω ±1/4% 1/8 W	75042	CEA T-2 obd
A2R15	0683-1015		R: fxd comp 100Ω ±5% 1/4 W	01121	CB 1015
A2R16	0683-1535		R: fxd comp 15 KΩ ±5% 1/4 W	01121	CB 1535
A2R17	0683-2405		R: fxd comp 24Ω ±5% 1/4 W	01121	CB 2405
A2R18	0683-2735	2	R: fxd comp 27 KΩ ±5% 1/4 W	01121	CB 2735
A2R19	0683-2025	4	R: fxd comp 2000Ω ±5% 1/4 W	01121	CB 2025
A2R20	0683-6815	1	R: fxd comp 680Ω ±5% 1/4 W	01121	CB 6815
A2R21	0683-1515	1	R: fxd comp 150Ω ±5% 1/4 W	01121	CB 1515
A2R22	0683-9125	1	R: fxd comp 9100Ω ±5% 1/4 W	01121	CB 9125
A2R23			Not assigned		
A2R24	0683-2735		R: fxd comp 27K ±5% 1/4 W	01121	CB 2735
A2R25	0683-2025		R: fxd comp 2000Ω ±5% 1/4 W	01121	CB 2025
A2R26	0683-1535		R: fxd comp 15KΩ ±5% 1/4 W	01121	CB 1535
A2R27	0683-1015		R: fxd comp 100Ω ±5% 1/4 W	01121	CB 1015
A2R28	0683-1525	1	R: fxd comp 1500Ω ±5% 1/4 W	01121	CB 1525
A2R29	0757-0480	1	R: fxd prec met flm 432 KΩ ±1% 1/8 W	19701	MF5C T-O obd
A2R30	0698-5446	1	R: fxd prec met flm 31.6 KΩ ±1/4% 1/8 W	75042	CEA T-2 obd
A2R31			Not assigned		
A2R32	0683-5625	1	R: fxd comp 5600Ω ±5% 1/4 W	01121	CB 5625
A2R33	0698-5444		R: fxd prec met flm 1100Ω ±1/4% 1/8 W	75042	CEA T-2 obd
A2R34	0757-0739	1	R: fxd prec met flm 2000Ω ±1% 1/4 W	19701	MF5C T-O obd
A2R35	0683-1035		R: fxd comp 10 KΩ ±5% 1/4 W	01121	CB 1035
A2R36	0698-3190	1	R: fxd prec met flm 100 KΩ ±1/4% 1/8 W	75042	CEA T-2 obd
A2R37, A2R38	0683-1035		R: fxd comp 10 KΩ ±5% 1/4 W	01121	CB 1035
A2R39	0683-5115		R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
A2R40	0683-1235		R: fxd comp 12K ±5% 1/4 W	01121	CB 1235
A2R41	0683-1035		R: fxd comp 10 KΩ ±5% 1/4 W	01121	CB 1035
A2R42			Not assigned		
A2R43	0683-1235	2	R: fxd comp 12K ±5% 1/4 W	01121	CB 1235
A2R44	0683-3925	1	R: fxd comp 3900Ω ±5% 1/4 W	01121	CB 3925
A2R45	0757-0339	1	R: fxd prec met flm 3010Ω ±1% 1/4 W	19701	MF6C T-O obd
A2R46	0757-0401	1	R: fxd prec met flm 100Ω ±1% 1/8 W	75042	CEA T-O obd
A2R47	0683-2035	1	R: fxd comp 20 KΩ ±5% 1/4 W	01121	CB 2035
A2R48	0683-3935	1	R: fxd comp 39 KΩ ±5% 1/4 W	01121	CB 3935
A2R49	0757-0831		R: fxd prec met flm 4320Ω ±1% 1/2 W	01121	CB 0831

MANUAL CHANGES

MODEL 3410A

AC MICROVOLTMETER

-hp- Part No. 03410-90002

► New or Revised Item

Instrument Serial Number	Make Manual Changes
ERRATA	ALL
953-00721 and above	#1
953-00801 and above	#2

Instrument Serial Number	Make Manual Changes

ERRATA

Page 2-1: In Paragragh 2-4 the Performance Checks should refer to Paragraph 5-5.
Paragraph 2-6 should list power requirements as 50 to 400 Hz.

Page 5-6: Figure 5-4, change A3R16 to A3R15.
► Paragraph 5-30b, adjust A1R10 for 7.5 V ± 5V.

► Page 5-8: Paragraph 5-42c, line 2 should read A4TP4.

Page 5-8: Paragraph 5-45 should refer to A2C1*, and A2C10*.

Page 6-3: Change Mechanical Part No. 7 to -hp- Part No. 1500-0253.

Page 6-4: Change A1C15 to 390 μF (0180-0294).
Change A1R10 to Part No. 2100-2031.
Change A2C1 to A2C1*.

Page 6-5: Change A2C10 to A2C10*.

Page 6-6: Change A3CR2, A3CR15, A3CR17 to 3.83 V Zener, (1902-3059).

Page 6-7: Change A3Q3, A3Q18, A3Q19, A3Q23, A3Q26, to 1854-0019 and delete 2N3646 from the description.
► Change A3Q4 to 1854-0475.
Add 270 Ω to description of A3R4.

Page 6-11: Change A4R65 Part No. to 0683-1535.

► Page 6-12: Change S5 to 3101-1234

Page 7-5: On the A1 Component Location Drawing, change CR3 near Q3 to read CR1.

Page 7-7: Change A1C4 value to 390.

Page 7-9: Change A3CR2, A3CR15, A3CR17, to 3.8 V.

CHANGE #1

Page 6-2: Change INDEX NO. 3 to 03410-00203.

Page 6-11: Change F1 to 2110-0202, 500 mAT.
Change J4 to 1251-2357.
Change A4R61 to 2100-2514.

Page 6-12: Change W1 to 8120-1348. Change S5 to Part No. 3101-1234.

CHANGE #2

► Page 6-6: Change A3C17 to 0180-0387 C fxd 47 μF

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